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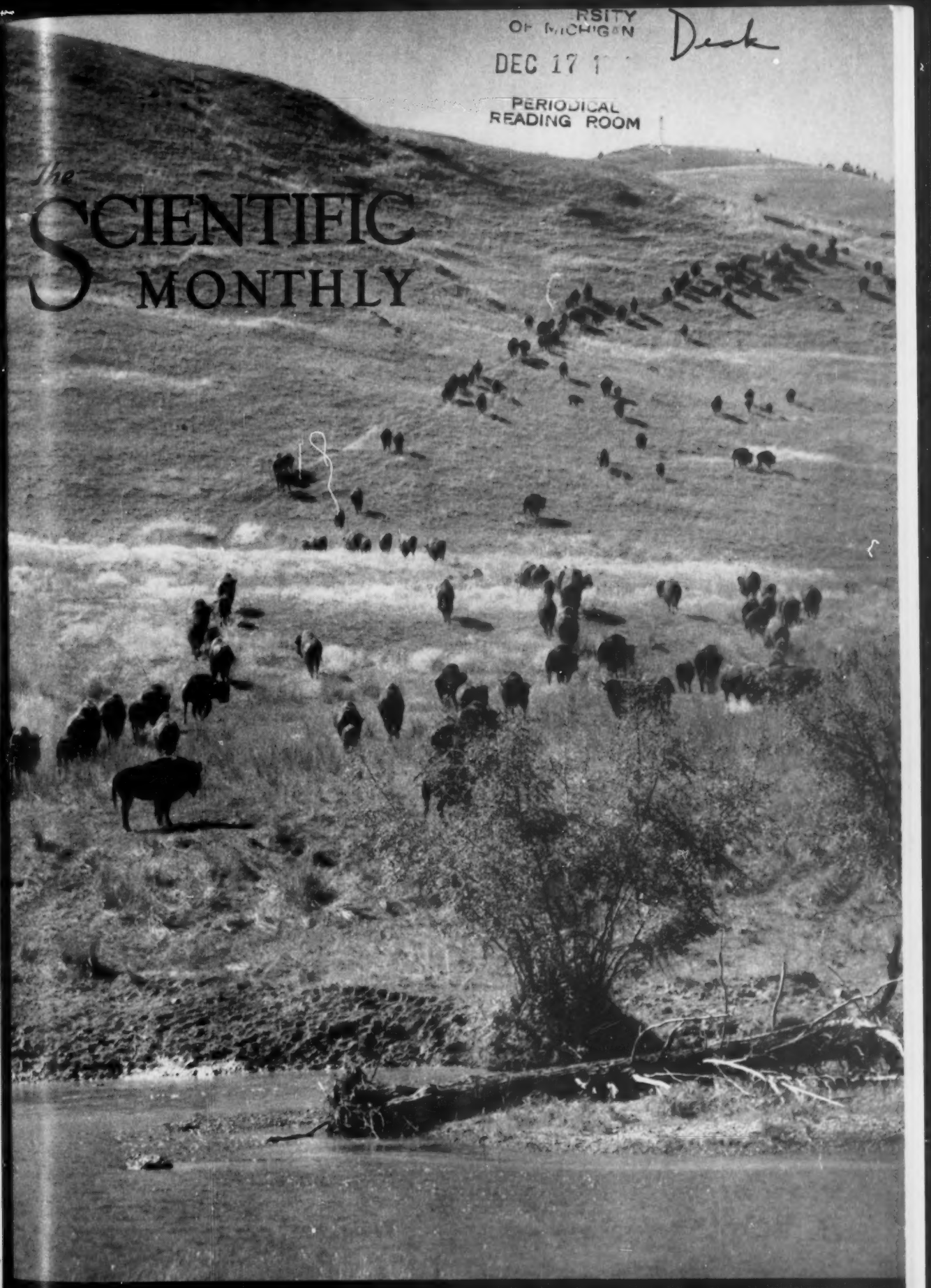

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THE SCIENTIFIC MONTHLY

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Annual Meeting, AAAS, Philadelphia, Pennsylvania, December 26–31, 1951

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Science and Technology

(From the Month's News Releases)

Typists' Boon

A Swedish inventor, head of the Atvidaberg typewriting institutes in Stockholm, has developed an ingenious device that registers electrically any variation from the correct touch in typing. A system of electric relays causes a red lamp to light up if the touch on the key lasts more than 1/100 second. By observing the signal flashes, a pupil can quickly learn to adjust his touch so as to achieve the degree of relaxation necessary for this complicated coordination technique.

Drifts Away!

Snow-Blo is a new electric snow-removal machine powered by a ½ h.p. capacitator-type motor that will toss snow as far away as 20 feet to either side. A reverse rotation switch provides for change of direction of throw. The machine rides on 8″ × 1.72″ wheels, with semipneumatic tires, has an adjustable handle, and comes equipped with 100 feet of plastic cord.

Bigger and Better Petunias

The first hybrid petunias, offered last year, have now been developed into "cytoplasmic sterile" plants which, free from the necessity of setting seed, can use all their energies in producing long-lasting flowers. By various breeding techniques, Herbert L. Everett, geneticist at the Connecticut Agricultural Experiment Station, is able to reproduce the sterile characteristic in almost any petunia. To eager petunia fanciers: Plants and seed are not yet in commercial production.

How Thick Is a Thin Film?

By using the Step Gage, developed by physicist Katherine B. Blodgett, films from 3 to 16 microinches may be accurately measured. A film of barium stearate is deposited on a plate of special plastic-enclosed glass, in a series of monomolecular layers, 0.1 microinch thick. Successive layers are deposited so as to build a series of steps of ten layers, each step one microinch thicker than the preceding one. When the gage is illuminated by white light, each step reflects a strip of color determined by its thickness, thus serving as a standard for comparison with other films that reflect interference colors. It may also be used in teaching the laws of reflection, polarization, and interference.

The Compleat Robot

The day of the robot machinist seems to be at hand if the giant brain said to be able to operate a machine tool in Detroit from an engineer's office in New York develops the many applications listed by its manufacturer. Tape-recorded perforations represent the essential blueprint dimensions for the part to be machined, and varying voltages in a sensor accurately control movement of the cutting tool and work piece. Deviations in the resulting product, if any, are the fault of the tool, not of the electronic device controlling it.

Magnifier

Complete with a pair of spring clamps, an ingenious magnifier may be snapped onto any standard thermometer, of which it will magnify a two-inch section. Operators can take accurate readings from as far away as six feet.

Diesel Shuttle

The Bureau of Mines, after exhaustive tests at the Central Experiment Station, Pittsburgh, has approved the use of Diesel electric shuttle cars for operation in noncoal mines. Among the restrictions attached to use are maintenance of adequate ventilation at all times, operation only in atmospheres that do not contain dangerous amounts of flammable gases, frequent atmospheric examination to determine what contaminants may be present and in what quantities, and the specification that the Diesel oil used must have a flash point greater than 140° F.

Desiplate and Desiguard

Practically indestructible, a cast-aluminum plate, 146 mm in diameter, is made for use in standard 6-inch glass desiccators or may be used separately as a support and cooling block. Support legs are integral and cannot break off, aluminum composition permits quick dissipation of heat, and the finish resists corrosion. A junior size holder allows the use of small vacuum desiccators (up to 160 mm ID) with safety. Lower half has solid surface to catch spilled liquids, upper part is perforated to relieve pressure, and handles make for safe carrying.

Lacemaking Up to Date

In manufacturing lace, a number of individual strip patterns of varying widths are basted together to make a finished roll up to 21 feet wide. Formerly, it was necessary to clip and remove the basting threads by hand before individual strips could be wound on flat strips of cardboard. Now basting threads of cellulose acetate are used; after the roll comes from the loom it is placed in a vacuum chamber, and an acetone solution completely dissolves the cellulose without harm to the lace. Solvent is subsequently recovered by the vacuum system and purified by distillation for re-use.

Dolls

A doll with three faces laughs, cries, or sleeps, as childish whim may require. She also has a "double" voice, which sounds both when she is squeezed and when she is released. Another type of doll, a bedtime playmate, has closed eyelids, sucks her thumb in a realistic manner, and is dressed in an infant's sleeping garment. Both dolls have heads and hands of plastic.

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THE
SCIENTIFIC MONTHLY
DECEMBER 1951

Scientific Landmarks from Philadelphia's Colonial Days

THOMAS D. COPE*

Dr. Cope (Ph.D., Pennsylvania), rooted in the soil of Chester County, Pennsylvania, since the 1680s, has been in the Physics Department of the University of Pennsylvania since 1906. "Scientists and amateurs" sprouted spontaneously from that soil even in the earliest days. Throughout the area John Bartram and Humphry Marshall, David Rittenhouse and the Reverend Henry Muhlenberg, were—and they still are—household heroes; the Chester County native just naturally thinks and dreams and boasts and writes about the great men his county and the adjacent areas have produced.

PHILADELPHIA, founded by William Penn in 1682, sprang from the Britain that in 1662 had brought forth the Royal Society "for promoting Natural Knowledge." The traits of the parent passed on to the offspring, for "scientists and amateurs" appeared in Philadelphia, and William Penn was one of them:

> [Penn] . . . was propounded Candidate of this Society by Mr. Houghton on 2 November 1681. At the next meeting of the Royal Society Mr. Houghton presented to the Society from Mr. Penn his Map of Pensilvania for which the Society returned their thanks, and on the same day [9 November 1681] W^m^ Pen Esq^r^ was elected a Fellow of the Society.[1]

William Penn contributed little directly to the work of the Royal Society, but indirectly he contributed much, for he established a province in which freedom of thought, freedom of inquiry, freedom of speech, "a free press and a public library," and free communication with the world were the ways of life. On such a soil and in such an atmosphere science throve.

Perhaps the landmark that best recalls William Penn is Pennsbury, his countryseat on the Delaware,[2] which has been attractively restored. Had affairs permitted, William Penn would have lived out his years at Pennsbury, close to nature and among the gardens in which his interest was so keen.

To his "green country town," in 1699, William Penn brought from England as his secretary and confidential agent James Logan, a brilliant young scholar of twenty-five. For his remaining fifty-two years Logan made Philadelphia his home. A district in North Philadelphia bears his name. The Academy of Natural Sciences and The Franklin Institute face on Logan Square. His name endures at Haverford College and at the University of Pennsylvania. Stenton, his countryseat, is a show place of eighteenth-century life. The finest landmark of all is the Loganian Library, which James

* The author wishes to acknowledge the invaluable assistance and the numerous courtesies extended him by the library staffs of the American Philosophical Society and of the University of Pennsylvania.

Logan collected, used, shared, and willed to the city. It was incorporated with the Library Company of Philadelphia in 1792 and is housed in the Ridgway Branch in South Philadelphia.[3] Scholars resort to it, for it contains one of the finest collections assembled during the eighteenth century, and it is rich in mathematical and astronomical literature through the centuries.

Logan lived a many-sided life. He served the province as its secretary, commissioner of property, chief justice, and as secretary of the council. He acted as governor for almost two years. He knew the ancient tongues and the modern ones as well. He translated *Cato's Moral Distiches* and *Cicero's Cato Major* into English and published them. Although public administration was his official duty, mathematics, astronomy, botany, and gardening comprised his intellectual life. He corresponded with distinguished Fellows of the Royal Society —William Jones, mathematician; Edmund Halley, astronomer; Peter Collinson, botanist; and Hans Sloane, physician, naturalist, president of the Royal Society, and founder of the British Museum. Four of his contributions were published in *Philosophical Transactions* between 1735 and 1738. They deal with the appearance of lightning flashes, the apparent sizes of sun and moon, an improvement of a nautical instrument, and pollination in Indian corn.

Logan's library, which contains all three editions of Newton's *Principia,* shows evidence in Logan's own hand of his critical study and mastery. He was in England during 1723 and 1724 and observed the total eclipse of the sun on May 11, 1724. Later, as a guest, he heard Edmund Halley report the eclipse to the Royal Society, with Isaac Newton in the chair. During this visit he secured proof sheets of Halley's *Astronomical Tables,* brought them to Philadelphia, and subjected them to prolonged critical study, of which evidence survives.[4]

Logania, a generic name introduced by Linnaeus himself to honor James Logan the botanist, survives in Loganiaceae. Sex in plants and the significance of pollination were moot questions in the early eighteenth century, so in his garden at Stenton Logan made studies of these concepts and phenomena. He controlled pollination in Indian corn by removing and by covering tassels and silk and by observing the effects on the grain. His studies were reported in *Philosophical Transactions* and were published in book form in Leyden in 1739. John Fothergill, F.R.S., translated them into English and published them in London in 1747.[5]

The Pennsylvania Hospital, the first hospital to be established in the American colonies, speaks for medicine in early Philadelphia. When it opened, exactly two hundred years ago, there stood behind it seventy years of proud medical tradition in the province. The original building, in the heart of the Old City, links the province to the mother country and to the Old World. Well-trained physicians from Great Britain had served the city in its earliest days, and others came as the years passed. Apprentices from the city and the province and from other colonies came to these practitioners, some of whom persuaded their pupils to continue study in Europe. Young physicians, returning to establish themselves in Philadelphia after years of study abroad, brought medical degrees from famous schools, personal acquaintance with Europe's leading medical men, and a firsthand knowledge of contemporary medicine.[6]

Thomas Bond founded the Pennsylvania Hospital. Young Bond came to Philadelphia from Maryland to study under John Kearsley, a famous practitioner and preceptor, and he continued his training in Paris in 1738 and 1739. During 1743 Benjamin Franklin, John Bartram, and Thomas Bond founded the American Philosophical Society.

From knowledge acquired in Paris and from visits in London medical circles in 1744 and 1748, Dr. Bond recognized the great need of a hospital in Philadelphia. He appealed to individuals and was asked, "What does Franklin think?" Bond turned to Franklin and, under the spell of that master publicist, promoter, and politician, plain citizens and the Provincial Assembly provided funds to build and equip the hospital and to put it in service.[7] In its museum and its library the Pennsylvania Hospital cherishes treasures that came to it in its early days. Among them are anatomical models and crayon drawings presented by John Fothergill, famous eighteenth-century London physician and one of the best friends that young Pennsylvania ever had.

There soon followed the first school of medicine in the American colonies. William Shippen, Jr., and John Morgan were Philadephia boys and schoolmates at Nottingham Academy. Shippen graduated from the College of New Jersey, Morgan from the College of Philadelphia. Both entered upon the study of medicine, Shippen with his father, Morgan with Dr. John Redman and as an apothecary at the hospital. Then they went separately to Europe.

Shippen earned his M.D. at Edinburgh in 1761 and brought home the warm friendship of some of Britain's ablest physicians and Dr. Fothergill's gifts

to the hospital. With the aid of the models and drawings Shippen began to give instruction in anatomy and midwifery.

Morgan took his M.D. at Edinburgh two years later. His thesis that pus is formed from the blood stream won international recognition. With friends he made the Grand Tour, visiting hospitals and medical schools, and studying instruction in medicine. Learned societies in many countries elected him to membership, among them the Royal Society of London.[1] He planned a school of medicine for Philadelphia and won the support of Thomas Penn, Benjamin Franklin, and of others in England. He came home in the spring of 1765 and laid his plans before the trustees of the College of Philadelphia. They elected him professor of the theory and practice of physick. Two weeks later, at commencement, he delivered a *Discourse upon the Institution of Medical Schools in America,* a classic of medical education.[7, 8]

The medical faculty of the college grew rapidly. Shippen was appointed in anatomy and surgery; Adam Kuhn, who had studied with Linnaeus, in materia medica and botany; Benjamin Rush, in chemistry. At the Pennsylvania Hospital Thomas Bond established clinical lectures. The Medical School granted its first degrees in 1768. In later years the Pennsylvania Hospital added to its treasures the famous library of Benjamin Smith Barton, professor of materia medica and botany at the University of Pennsylvania and teacher of a long line of distinguished pupils.

James Logan was generous to young men of character and intelligence who could appreciate his intellectual interests. He lent them his books, helped them with foreign languages, encouraged their undertakings, and introduced them to kindred spirits in the colonies and in Europe. Among the many whom Logan helped on their way was John Bartram, who was born a farmer's son in 1699 at Darby. He developed an absorbing interest in nature, inherited a farm, bought a few acres on the Schuylkill, planted a garden and built a house there. In the garden he planted trees, shrubs, and flowers that appealed to his curiosity and to his sense of beauty. With a little help from James Logan, Joseph Breitnall, merchant-importer, and others, Bartram established contacts with kindred souls in Europe and in the colonies.

Into his garden and out of it there flowed for half a century and more such streams of plants and of letters as to stagger the imagination. Bartram made long expeditions into the wilds, northward and westward, eastward to the coast, and far southward into Florida to secure specimens for his clients. He corresponded with Collinson, Fothergill, and Sloane, all Fellows of the Royal Society, Queen Ulrica and Linnaeus in Sweden, Gronovius in Holland, Dalibard in France, and with Dillenius at Oxford. In the colonies he exchanged letters and specimens with all his contemporaries of kindred interests. King George III appointed him King's botanist with a modest stipend.[10]

Bartram contributed in a major way toward placing the flora of the American colonies before botanists in Europe and in the colonies. He supplied horticulturists in England and elsewhere with living plants, roots, seeds, and dried specimens from the colonies. Of eight scientific contributions he sent to the Royal Society which were published in *Philosophical Transactions,* five concerned insects, one the teeth of a rattlesnake, one mussels and oysters, one a display of the aurora borealis.

John Bartram contributed also to experimental botany. He repeated James Logan's experiments on sex phenomena and pollination in Indian corn with the red campion, *Lychnis dioica.* And he was an early student of plant hybridization. Letters and a bit of manuscript show that Bartram discussed the phenomena of hybridization with William Byrd of Virginia and Peter Collinson of London about 1740. John Bartram's Garden, now under the care of the Fairmount Park Commission, lies on the right bank of the Schuylkill in southwestern Philadelphia. It has been there for two centuries and more.

William Bartram, son of John and his second wife, Ann Mendenhall, and his twin sister, Elizabeth, were born at the Garden on April 20, 1739. William (Billy) called the Garden "home" through a long life. He died there in 1823. Billy received the finest education that Philadelphia could offer, and early in life revealed unusual talents, for he had his father's eye and ear and heart for flowers, birds, and landscape; he could draw exceptionally well, and he could write.

A distinguished career must be told in a few words: William Bartram traveled with his father, and alone after his father was too old to travel, returning to the Garden in 1778. In 1791 he published his *Travels.* Editions followed in London and in Dublin, and the book was translated into German, Dutch, and French. It was republished in America in 1928 and again in 1940. "Wordsworth and Coleridge devoured the *Travels.*" Carlyle wrote to Emerson about the *Travels.* Its contributions to literature and to natural history have been enormous.

When fountains play in Xanadu, and the sacred river meanders, reaches the measureless cavern,

and sinks in tumult, one thinks of John and Billy Bartram in their Garden on the Schuylkill. They saw the fountains, and the meandering river, and the caverns in Florida and told about them. Billy visited them again and retold their story well. Samuel Taylor Coleridge told it again in verse.

As a youth in Boston Benjamin Franklin worked for his living, learned printing, and wrote for the newspapers. Led by uncanny foresight he ran away from his native city in his eighteenth year and headed straight for Philadelphia, where he found himself. Twenty-six of his ensuing sixty-six years were spent in Europe on public business, and Philadelphia and the world lay equal claim to Benjamin Franklin as their own.[11] Landmarks[12] that recall B. Franklin, scientist, are so numerous that we leave all others and turn to the nooks in the Old City that he knew so well—Philosophical Hall,[13] on State House Square, and Franklin Court, two blocks to the east of the square. Only two long lifetimes end-to-end stretch back to the days when Dr. Franklin was living his last years in Franklin Court and was presiding at meetings of the Philosophical Society when he was able. There are men known to the writer who can recall a great-grandmother who, when a little girl, saw President Washington. Perhaps there are similar memories of Dr. Franklin.

On May 14, 1743, Franklin published *A Proposal for Promoting Useful Knowledge among the British Plantations in America,* and the American Philosophical Society was born. The older it grows the more vitality it acquires. Benjamin Franklin, John Bartram, and Thomas Bond were its sturdy forebears. It and the American Society held at Philadelphia for Promoting Useful Knowledge merged in 1768 and elected Franklin president. He was re-elected annually as long as he lived.

After the Revolution, the Philosophical Society built its home on State House Square. Dr. Franklin had returned from France in September 1785. Although in his eightieth year and none too well, he could still "meet defeat and mock it." He was the most generous original contributor to the building fund, and, when contributions lagged, Franklin doubled his contribution and lent the society all that it needed to complete the building. The society met in its new home for the first time on November 20, 1789; Dr. Franklin was too ill to be present.

Franklin Court, between Market and Chestnut and Third and Fourth Streets, is being restored, in part, by the federal government, in the national park now in course of development. Benjamin and Deborah Franklin built their home in the court during the 1760s. Mrs. Franklin and her daughter, who married in 1767, occupied it. Mrs. Franklin died in 1774. Franklin lived there after his return from England in 1775 until his departure for France during the following year. When he returned to stay in 1785, he was escorted to the court in triumph, and for his remaining five years he lived there with his married daughter. In the court Dr. Franklin received delegates who came to Philadelphia in 1787 to draw up a constitution for the United States. And to the court he at times invited the Philosophical Society when he was unable to go to Philosophical Hall. Dr. Franklin closed his eyes in Franklin Court on April 17, 1790. He and Deborah his wife lie in Christ Church Burying Ground near by.

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Symposium on the Application of Ecology to Water Conservation*

A CHRONIC problem for the scientist is the translation of research into action. Here the scientist is faced with a dilemma. If he himself devotes attention to application of his results, then he no longer has time for more research; if he does not apply his results, then the work may be neglected for years. The research man wants to continue his investigations and also wants to apply his results. The solution of this problem can be found by better understanding between the investigator and the administrator.

For the purpose of furthering understanding a symposium was organized about the subject of water conservation. Administrators from a variety of fields were asked to present their opinions about the role of ecological research in advancing conservation of our water supplies. After each administrator spoke, a research ecologist commented briefly on the subject. We hope that this meeting helped to improve relations between investigator and administrator.

One aspect of the general problem is the difficulty of obtaining means to conduct ecological research before a situation reaches an emergency state. This condition can be traced largely to a failure of ecologists and administrators to understand one another. Ecologists have lacked imagination in application of their results, and administrators have been submerged in daily routine. The result is that, when a situation becomes critical, the ecologist has no information and the administrator is so busy "doing something" that he couldn't utilize information if he could get it.

Only by better communication can this chronic problem be solved. Already, ecologists and administrators are occasionally sitting down together to prepare for the control of anticipated problems. The result should be that administrators will obtain solutions to problems and ecologists will have increased opportunities for research.

DAVID E. DAVIS

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* Presented at the Ecological Society of America, Sept. 10, 1951, Minneapolis, Minn., by the Committee on Applied Ecology. David E. Davis served as chairman of the symposium.

Applied Ecology in Public Health

F. L. WOODWARD

Minnesota Department of Health, Minneapolis, Minnesota

THOSE of us who are not especially trained in biology are likely to consider ecology as a high-level science with which we are little concerned. Many public health workers are in this category. Yet, if we think of ecology in terms of its simple definition—the study of the relationship of organisms to their environment—we can see that a large part of public health work is applied ecology. Vaccination and immunization are efforts to protect the individual from his environment, and isolation and quarantine are practiced for the purpose of removing sources of infection from the environment for the protection of other members of society. Water purification, milk pasteurization, insect and rodent control, water pollution control, housing sanitation, community sanitation programs, smoke abatement, and industrial hygiene are all measures to control or alter the environment for the benefit of mankind. All these activities are based on knowledge, gained through experience or research, of the effects of an unwholesome environment on the public health.

Minnesota was one of the first states to employ a biologist on its water pollution control staff and to recognize the study of the types and abundance of bottom fauna as a reliable criterion of the degree

of pollution. Such studies have frequently furnished valuable information that could not be obtained by use of the conventional bacteriological and chemical procedures alone. Studies of plankton organisms in the water have also been used extensively to measure the extent and effect of pollution. These are examples of applied ecology in water conservation.

Summer visitors to our state soon learn that Minnesota is cursed with an abundance of mosquitoes. Although these mosquitoes have not been definitely implicated as carriers of disease, they are regarded as a health problem in that they interfere with sleep and with the enjoyment of life. Local control has been reasonably successful, but some experts still doubt that wide-scale control can be effected. From a strictly health standpoint it is likely that the mosquito problem could be greatly reduced by an extensive program of drainage, filling, dredging, and shoreline improvement. Such measures would, however, increase the rate of runoff and downstream flood problems, and inevitably result in lowered lake and ground-water levels. Such a program is not compatible with the necessity for conservation of water and agricultural resources. It would also impair the propagation of fish and game and reduce the recreational and aesthetic values of our lakes and streams. It appears, then, that considerable dependence must be placed on insecticidal treatment of larvae and adults. Here, again, the sportsman and conservationist are interested in any possible effect on fish and game. Thus the application of ecological principles to the problem of mosquito control must take into account environmental relationships affecting other interests.

The impounding of water for flood control or stream flow regulation, and the development of new irrigation projects in areas where there is a known incidence of equine-type encephalitis, call attention to the probable role of mosquitoes in the transmission of this disease. Extensive studies are being undertaken to determine whether the creation of new water areas is likely to increase the importance of this disease among men and animals and, if so, to devise control measures. Such changes in stream flow characteristics may affect the quality of surface waters for domestic water supplies. The effects of impoundment of water may often be advantageous in providing presedimentation, increasing water depths, and bringing about more uniform chemical and bacteriological quality. On the other hand, the extensive pumping of ground water for irrigation, commonly practiced in coastal states, may adversely affect domestic water wells by lowering the ground-water level or increasing the mineral content. The recharge of ground-water strata with surface water, formerly regarded with disfavor because of the detrimental effect on the quality of ground water, has now become a necessity in some areas in order to maintain levels and to guard against salt-water intrusion.

Health authorities in the West and Southwest are well aware of the higher incidence of enteric diseases in the areas where sewage-polluted water is used for irrigation. Infection may result from drinking the readily available irrigation water or from handling or eating contaminated vegetables or fruits. In such areas it is necessary not only to make certain of obtaining safe drinking water, but also to provide a high degree of treatment of sewage, including disinfection. Thus the multiple utilization of water resources may impose additional responsibility in the provision of sanitary facilities for the protection of the public health.

In recent years there has been an increase in reports of livestock losses from ingestion of toxic algae. It is probable that the incidence of cases has not increased to the extent indicated, but that several factors, including the rising value of livestock, have brought more cases to public attention. Although human beings are usually more fastidious than animals in their selection of drinking water, it is conceivable that the development of algal blooms in water supply impoundments or reservoirs might result in mass human poisonings. Even the loss of livestock is a matter of considerable economic importance. Several problems are not completely solved in this field. They include identification of the toxic agent, determination of the factors that cause the toxic bloom, possible effects of the bloom on persons swimming in the water, and practical means of predicting and preventing the development of the bloom.

A problem in water sanitation that has come to light in the past six years is that of nitrate poisoning of infants. It was at first thought that high nitrates in well waters were probably directly related to faulty location and construction with respect to sources of human or animal contamination. If this relationship could have been established, it would have strengthened the construction standards developed for protection against bacterial contamination. Unfortunately, it has not been possible to do this, and up to the present time no explanation has been found for the wide variation in the nitrate content of wells of similar depth and location. Bacteriological soil studies now under way may resolve some of the questions. A great deal of physiological research is needed to explain why one of two infants fed formulas containing apparently identical amounts of nitrate will develop methemoglobinemia whereas the other exhibits no symptoms,

and why susceptibility disappears at two or three months of age, and to establish definite safe limits of nitrate nitrogen. The present generally accepted standard of 10 ppm is probably ultraconservative. One difficulty in these studies is the problem of making the necessary tests on infants of the susceptible age.

One of the most troublesome problems confronting water pollution abatement agencies is that of the fertility of lakes and streams receiving purified sewage effluents. A community or industry that has installed modern complete treatment works for its wastes probably has a right to expect that complaints of nuisances attributed to the discharge of the wastes will cease. However, algae and other aquatic growths that thrive on the nutrients in sewage are often more productive of offensive odors, and may be more objectionable in appearance, than untreated sewage, and these growths may continue to be prolific after the sewage or industrial waste has been treated to a high degree. This is particularly true where the effluent is discharged into a shallow lake or other body of quiet water, or where the dilution factor is low. Thus a lake or stream that has been heavily polluted may still be a source of complaint because of odors, fish losses, or bad appearance after the community or industry has complied with all orders for pollution abatement. Research is urgently needed to develop means of reducing the phosphorus and nitrogen content of sewage effluents.

This discussion has touched upon several areas of relationship between water conservation or water utilization and public health. Some of the problems raised require only recognition and consideration of the interests affected, whereas others suggest definite needs for research. Among the latter are (1) investigation of the effects on the incidence of mosquito-borne disease of the manipulation of water areas for flood control, navigation, runoff control, and irrigation; (2) studies of toxic algae; (3) further studies relating to the nitrate content of ground waters; and (4) development of methods for control of fertility of waters receiving sewage and industrial waste effluents.

Forestry and Applied Ecology

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IT IS estimated that prior to the coming of the white man to this continent about 850 million acres were covered with forest growth of one type or another. This acreage has been reduced at the present time to about 624 million acres, or one third the area of the continental United States exclusive of Alaska. This is an area as large as all the states east of the Mississippi River, with the states of Kansas and Louisiana thrown in. Three quarters of this forest land has a major moderating influence on watershed production, but owing to poor cutting practices, overgrazing, and fire much of the area's protective capacity has been lost.

Within the forest acreage are a variety of climatic and geologic conditions. Soils vary from thin sands to heavy clays. Topography varies from steep, mountainous areas to swamps, and plant cover from sparse vegetation in the dry desert regions to dense cover in parts of the Northern and Eastern states.

Foresters for the past fifty years have been aware that forests play an important role in the production of rainfall. This is evidenced by the provision contained in the Weeks Law of 1911, which provides for fire protection for the purpose of conserving the forests and the water supply of the states. In 1909 the Wagon Wheel Gap studies in Colorado were organized by the U. S. Forest Service in cooperation with the Weather Bureau.

The early-day concept of water management by the rank and file of foresters was one of the establishment of protection forests, where little or no use was made of other resources. Today most foresters have a greater realization of the importance of the water resource, but many still believe that any forestry practice carried on in the forest is water management. To date there has been a lack of basic understanding by the men on the ground of the natural laws governing the operation of the water cycle, and one of the first tasks is to show them that watershed management is most essential in any program of land management.

In proceeding with any program we must know with what we have to deal; to determine this detailed watershed surveys will be necessary. These can bring together all the important factors—biological, physical, hydrologic, economic, and social. Such surveys will indicate how much water is available. They will reveal where the water goes—

to plants or stream flow or underground reservoirs —or whether it is lost through evaporation. They will indicate opportunities for regulating flow and improvement of its quality. They will show areas and types of forests that can be used without danger and those that should be managed only as protection forests. Vegetation will be evaluated not only in respect to its type, volume, and usefulness, but also as to the effective use of water and its contribution to soil stabilization.

The vegetation of a forest area affects the performance of water in several different ways. The amount of precipitation that reaches the ground is dependent upon the ground cover. Leaves, branches, and stems of plants intercept much of the precipitation, and this is later evaporated. Studies have been made that indicate that rainfall interception losses during rains of .5 inch or more vary from about 10 per cent in open forest to as much as 40 per cent in densely forested areas. Coniferous forests intercept as much as 30 per cent of the winter snowfall. The presence or absence of a dense plant cover can thus make up to as much as a 30–50 per cent difference in the amount of water that reaches the ground surface.

Vegetation also shades the ground and minimizes wind movement, effects which tend to reduce evaporation and snow-melting rates. It has been found that evaporation of water from snow in forest areas may be only about one third as fast as from open areas. These factors that reduce evaporation losses and retard snow melt tend to offset the effect of interception losses.

Vegetation affects the infiltration characteristic of a site in several ways. It softens or prevents direct impact of raindrops on the soil. This minimizes the chance for soil detachment and subsequent plugging of soil pores. It also obstructs the movement of water over the surface. Organic matter on and in the soil lessens the depth and hardness of frost, thereby maintaining a porous structure during freezing weather. The roots create channels that aid in the downward passage of water.

Removal or lessening the plant and litter cover destroys or diminishes all these aids to infiltration. Test plots have demonstrated that infiltration rates can be reduced by as much as 75–90 per cent when densely covered forest sites are denuded by fire or when areas are depleted and compacted by overgrazing.

Evapo-transpiration losses are another factor affected by the forest cover. Evaporation losses occur mainly in the upper foot of soil, whereas transpiration losses occur to the depth of root penetration. The amount of water lost through evapotranspiration amounts to a considerable quantity. Recent studies in Utah, for example, show that aspen forest sites with a 6-foot-deep root system consume about 18 inches of water per growing season, compared to a 14-inch loss on sites having a herbaceous cover with a 4-foot-deep root system, and to a loss of only about 10 inches for bare sites.

Plants that grow along the margins of swamps, lakes, and streams and on areas where the water table is high, transpire greater quantities of water than those that grow on well-drained sites. Cattails use from 6 to 100 inches per year, alders, cottonwood, willows, etc., around 50 inches, swamp grass from 30 to 50 inches. Such losses may be beneficial where storage is important for flood control, or they may be detrimental because they reduce water yields.

The discharge characteristics of a watershed are materially affected by its cover. For example, in densely forested areas having a deep, porous mantle, most of the water leaves the area as seepage, in contrast to overland flow. Watershed management is concerned about the quality of water, whether it is hard or soft, colorless, odorless, or tasteless, and especially concerned as to whether it is clear or carries a heavy load of sediment.

The vegetation of a watershed operates in several ways to minimize mantle erosion. It can prevent or minimize the detachment of soil particles by sheltering soil from the force of wind, raindrops, and running water. It can impede and may even halt movement of particles being transported over the land surface by running water. It tends also, through the binding power of roots, to minimize mantle movement by creep, slump, and cavitation.

The above in a very brief way outlines some of the major effects of forest cover on water yield.

As mentioned earlier, the principles of hydrology comprise an entirely new field that is scarcely known to most foresters and others dealing with management of land. The chief reason, no doubt, why so little is known about land use–stream flow relations is the lack of experimental data. And there is no doubt a very plausible explanation for this situation. Stream flow studies must be carried out on a drainage area basis, and experimental watersheds are expensive to install and difficult to operate. Many years of continuous, accurate records are required before acceptable results can be obtained. There is also the problem of the selection of suitable areas that will meet requirements with regard to geology, soils, topography, and rainfall.

As administrators we realize that research cannot give us all the answers immediately. We do need basic data that will lead to a better understanding of the ways in which forests function in control of water and conservation of water resources.

We need to know how best to manage the forests and forest lands to meet specific needs. For example, in the management of municipal and industrial watersheds there exists an opportunity for integrated, high-quality, long-rotation timber crops with the production of a high yield of quality water. Timber management practices can also be directed toward achieving sustained summer flow from headwater areas supplying water for hydroelectric power.

The use of forest cover for erosion control has in general not been questioned. Even this may be wrong, however, in a few instances. It is my understanding that under unusual soil conditions natural land slips on steep slopes are more common under large trees than under low herbaceous cover. Thus it is difficult to generalize, and to do so may be misleading in the solution of local problems.

The most pertinent of all facts known to date is that abuse and damage of the forest soils start into motion degenerative processes which may be inconspicuous at first, but which can produce gradually accelerating changes in soil structure that ultimately result in impairment of the water resource.

Water Conservation and Grassland

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CONSERVATION of water on grassland raises a host of ecological questions, relating particularly to possible changes in plant communities. Moreover, it stimulates interest in problems of soil and moisture conservation generally, and in flood control.

Numerous investigations have shown that soil type, nature of the rainfall, and condition of the surface affect the rate of intake of water by soils. Only two decades ago Lowdermilk discovered that "The formation of a fine-textured layer at the surface of a bare soil, as a result of filtering suspended particles from percolating muddy water, is . . . the decisive condition which increases the surficial runoff from bare surfaces." In 1939 Duley and Kelley, working with cultivated soils of Nebraska, first clearly described the nature of the layer of soil at the surface, which Lowdermilk found reduced infiltration. They found that even an artificial mulch of plant material, on cultivated soil, prevented formation of a compact layer at the soil surface. Such layers, though only a few millimeters thick, are a primary cause of runoff and erosion. Furthermore, they found that over wide differences in soils a mulch had a larger influence on infiltration capacity than soil type, initial moisture content, and rainfall intensity combined. Borst and Woodburn reported in 1942 that the major effect of mulch in erosion control was through elimination of raindrop impact, rather than in reduction of overland flow velocity. Ellison's researches in 1944–45 into effects of raindrops on various soils also indicated that complete prevention of erosion is ordinarily possible only under a cover sufficiently dense and close enough to the soil surface to prevent splashing of soil by raindrops.

It is now plain that on almost all grassland protection will be dependent on natural mulch through several months of the year, because green or cured and upright foliage is seasonal. In most natural grassland, climate permits only a sparse basal cover of living plants, even in climax or nearly climax vegetation. When much of the foliage is removed by grazing, the remaining live plant material does not afford adequate soil protection. To hold erosion to the minimum and to maintain maximum infiltration of rain water, it is evident that living plants must be supported by a layer of natural mulch. Without it we may expect loss of soil and retrogression to grassland communities with lower water requirements.

Infiltration on grassland is generally greater than on bare soils because of the surface protection offered by the top growth. Raindrops impinging upon bare soil cause detachment of the soil particles, and this loosening of the particles at the surface gives the runoff waters an opportunity to act upon them. Runoff water, owing to its turbulence, keeps the soil particles in suspension. Rearrangement of the soil particles at the ground surface serves to reduce the infiltration rate by puddling. Tamping by raindrops tends to alter the soil structure near the surface, resulting in a thin, compacted layer that further reduces the infiltration rate and thereby increases the runoff rates and erosion.

Laboratory results based on controlled experiments laid the basis for field trials. Then a Mobile Raindrop Applicator was devised by the Soil Conservation Service, which since 1949 has been moving from range to range evaluating effects of

different kinds and amounts of natural cover on different soils. Ben O. Osborn was in charge.

Field tests were conducted in series to represent variations in cover on the same range site or soil unit. A small-sized plot (12″ × 18″) avoided excessive variations in soil and cover within a single sample. It also permitted fairly uniform coverage by a single dominant species when effects of different species were to be considered.

The drops formed by the applicator had an average diameter of about 5 mm, similar in size to the larger drops in a heavy summer thunderstorm. They fell 14 feet to the ground, where their velocity was approximately 25 feet per second. This is within 80 per cent of the terminal velocity for this size drop falling vertically without the added force of wind to drive it.

The standard application of water in these tests was 2 inches in 20 minutes. This is equivalent to a precipitation rate of 6 inches per hour. Such rates are not uncommon on the prairies but only for short periods. Such a rate occurs for 5 minutes about one year in fifteen.

These evaluations have thus far provided us with a tentative scale of effectiveness for different amounts of cover on natural grassland. The degree of protection needed by different soils, however, depends upon characteristics of the soils. The amount of protection needed at different seasons depends also upon the hazards involved in the characteristic storms of the season. These variables have not been sufficiently evaluated to permit devolpment of standards of adequate protection for different range sites by seasons.

The goal, of course, is to achieve stability of the soil surface and prevent appreciable soil and water losses from points of origin on the watershed. This ideal requires a cover of about 98 per cent effectiveness in preventing splash, which requires on the average 5,000 pounds per acre of forage and mulch combined, covering 85 per cent of the soil surface. On the various sites evaluated, these minimum amounts of splash were usually attained with 4,500–6,000 pounds of cover per acre. A problem for ecologists is: When does amount of cover become so great that interception of small showers offsets improved soil water storage from big storms? One of the most significant findings is that native range cover, across the prairies and plains, can, and does exist locally for each site, in sufficient quantity to prevent significant soil losses from "points of origin" on every site tested.

Likewise, cover and soil conditions can be such as to prevent significant water losses from 2 inches of rain in 20 minutes on all sites that have the storage and disposal capacities to handle this amount of water in this time interval. Certain soils of shallow profile development or with restrictive horizons near the surface did not absorb all the water applied under any cover conditions.

The amount of cover on the soil surface at the time of the rain is the primary factor in preventing soil detachment. Both the bulk or total weight of the cover and the thoroughness of its distribution over the surface are important. For maximum water intake, surface cover is necessary to prevent sealing of the soil by raindrop impact. Soil conditions also influence water intake and loss. These conditions are related to the state of ecological development or deterioration of the cover. Administrators, and therefore ecologists, have a problem in that land users may not appreciate the cover high in ecological succession.

Osborn found that effectiveness of cover in preventing both soil and water losses is greatest when range is in virtually climax condition, and it progressively declines as range condition declines and the degree of current grazing use increases. On most sites, however, soil splash can be controlled even in the lowest range condition by nonuse or light grazing to leave sufficient cover on the surface to intercept the raindrops. When the soil surface is stabilized, conditions are favorable for improved water intake and development of the cover toward climax.

The many flood-producing storms in the central United States grasslands last year raise questions. Data on how grass cover may reduce flood damages are meager. Grass cover in this respect is usually compared with forest cover, and both are contrasted with cultivated lands. Research covering small grassed watersheds has in almost all cases been a comparison simply of pasture versus various systems applied to cultivated land, rather than between differently managed pastures.

Frank L. Duley has reported that "Where grass is not overgrazed and growth is dense, the infiltration rate is likely to remain high for a long time and continue at a high point during successive rains. On the Hydrologic Project in Webster county in southern Nebraska the maximum peak rate of runoff on heavily grazed native pasture was 1.01 inches per hour. On lightly grazed land it was 0.72 inch per hour." This is a reduction in peak flow of about 28 per cent. "An excessively heavy rain falling over a local area sometimes may so greatly exceed the infiltration capacity of the soil, even on grassland, that the runoff may be high in spite of a high infiltration rate. The fact that grass permits very little erosion also enhances its value for flood control. The sediment carried by erosion

from cultivated land increases in many ways the menace from floods.

"When there is some lapse of time between rains, a soil well protected by grass, other vegetation, or debris may absorb very large amounts of water over the course of a few weeks, even though its moisture content may be near field capacity. It is chiefly when rains are excessive or are more or less continuous over several days that good grassland is likely to show large amounts of runoff."

Ecology, Water Conservation, and the Shellfisheries

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SHELLFISH have been and are a major product harvested in United States waters. Marine crustaceans and mollusks, regularly used as food, include three species of oysters, four of clams, four of mussels, two of scallops, four of crabs, four of shrimp, two of lobsters, and one of crayfish. There are others, but they are not of sufficient importance to mention here. The total production of shellfish in 1945, using this general classification, amounted to 517,224,000 pounds, valued at $82,332,000, or 17.5 per cent of the total edible sea food taken from the sea, and representing 32.4 per cent of the value. Averaging catch and volume records from 1880 to 1940, two shellfish, oysters and shrimp, ranked by volume in the first ten species in the country. Oysters ranked first, and shrimp ranked seventh in value. Since 1940, shrimp have increased in both catch and value.

The relationship of all these animals to their environment, and the role of the ecologist in their management, cannot be covered in a short paper. This discussion will be concentrated, therefore, on the relatively nonmigratory species, principally the mollusks. Harvesting a crop is easier if the organism is more or less immobile throughout most of its life. Mollusks, which are mostly sedentary after the larval stage, are easy to catch as compared to commercially important crustaceans, which are migratory to a greater or less extent. The approach to utilization of a migratory species, as distinguished from a nonmigratory one, is different, and the two groups will be discussed separately.

The blue crab (*Callinectes sapidus*), which is widely distributed along the Atlantic and Gulf Coasts and which makes rather extended migrations, is an illustration of the complexities of managing a migratory species. This crab lays its eggs in waters with a salt content of 15–20 parts per thousand. With the eggs attached, the female migrates to more saline water (20–27 0/000), where hatching occurs during the summer months. The larval crabs spend some time in this environment and gradually disperse, many moving or being carried to brackish water areas. In the Chesapeake Bay, some growing areas are almost 200 miles from the hatching grounds. Mating takes place in the second year in brackish water, and after a few months the female begins her migration toward the ocean. The entire life cycle covers only about two and one-half years.

Most of the males remain in brackish waters after maturity, whereas the females congregate near the mouth of the bays in the saline waters during the hatching period in late spring and summer. Crabs are prolific, laying as many as 3,000,000 eggs per female and having two or more broods in a single summer.

Numerous studies have been made of the blue crab, looking toward the conservation of the species. The commercial catch has fluctuated widely, with periods of abundance followed by years of extreme scarcity. The administrator has been faced with two problems in the fishery: the interstate problem of joint controls as a result of migration across state boundaries, and the fluctuating size of the population, with little apparent relationship to fishing intensity or the size of the spawning population. The ecologist is plagued with the explanation of this extreme variation in abundance. No sound management program can be administered until the answer is forthcoming. In the past it was assumed by biologists and administrators alike that scarcity was the result of overfishing. Tremendous populations produced from very small stocks have generally dispelled this idea. Recent scientific studies seem to point to salinity fluctuations on the hatching grounds as the limiting factor in survival of the *zoea* and *megalops* stages. Instead of numerous restrictions on catch, imposed as conservation measures by the various states, the marine biologist recommends efficiency in harvesting the crop, with restrictions designed primarily to reduce

waste and to take advantage of rapid growth. This probable environmental relationship has been difficult for the amateur conservationist to accept. One of the problems faced by the public administrator today is that some conservation clubs, leagues, and federations have been oversold on the idea of overfishing as the sole cause of fluctuations. Anyone advocating expanded fishing in a given fishery is risking attacks from the very groups who normally are the most ardent supporters of conservation. Wide dissemination of newly discovered facts dealing with commercial or sport species becomes almost essential to management. Research is needed now to pinpoint the findings thus far, so that every possible crab can be harvested before death. The only restrictions necessary, then, would be proper size limits to reduce waste, and regulatory powers to the administrator to permit efficient harvesting or to reduce the take when the population falls below the level considered safe for reproduction.

The shrimp fishery, although of equal interest, would take too long to cover here. It is enough to say that it has shown no signs of a decline in the size of the population, even with ever-increasing exploitation. Whether economic factors will act to prevent depletion before biological considerations become paramount remains to be seen. The administrator looks to the ecologist, however, to establish the biological limitations of the fishery before an emergency exists. Only then can sound administration guarantee maximum sustained production commensurate with the potential capabilities of the species.

A characteristic of almost all commercially important mollusks is that they are low in the food chain in the sea. Most are primary feeders, only one step away from the basic nutrients. Their productive potential is high as contrasted to some of the carnivorous fishes, such as the marlins, bluefish, sailfish, and others. Biologists and economists alike have repeatedly pointed out the tremendous losses sustained in the sea from nutrients up the chain to the higher carnivorous animals. If the sea is to be used efficiently as a major source of protein food, we must look toward the low-food-chain animals, where the potential for expansion is greatest.

The oyster *Crassostrea virginica* and the clams *Venus mercenaria* and *Mya arenaria* are great potential marine resources. It should be emphasized that they are potential resources, even though the catch is high today, since production could be expanded several times by utilizing the available information.

The Eastern oyster has been intensively studied for the past fifty years. The recently published bibliography of scientific papers on oysters, with an abstract of each, was a volume of more than 450 pages. Today probably more biologists are studying oysters than any other marine animal. You may ask why so much work has been concentrated on this mollusk. Since the oyster is sedentary after the larval stage, and is concentrated in relatively shallow waters of 25 feet or less, it lends itself particularly well to exploitation. Oyster beds became depleted long before boats and gears had been devised to exploit other marine forms. Depletion gave rise to concern about causes, which resulted in increased research.

It was discovered in the eighteenth century that oysters could be cultivated and farmed, using procedures comparable to land farming. Beds along the New England coast became depleted in the early nineteenth century. Rigorous environmental conditions, coupled with intensive fishing, resulted in removal of all oysters. The beds were eventually leased by growers, and in Long Island Sound and adjacent waters practically all oysters are now grown by private industry. Seed beds are also farmed privately, which probably indicates that setting was low even on these superior setting areas. In most waters south of Long Island Sound, the seed-producing bottoms are public lands, since adequate reproduction takes place, even though the beds are poorly managed.

The methods of oyster culture being followed in the industry in the North Atlantic area and upper Chesapeake Bay are quite dissimilar. In New England most of the beds, including seed beds, are owned or leased by private individuals. Shells are planted on the seed beds as cultch for attachment of larvae. Frequently a stock of mature spawners is also placed upon the bed. Sometime after setting, the small oysters, or "spat," are dredged and transplanted to growing bottoms. Experience has shown that oysters will grow well on certain bottoms, but no set will be obtained. The absence of set on growing bars is important, since attachment of seed to living oysters results in a slower growing animal, of less desirable shape, and poses a marketing problem. The oysters remain on the growing beds for two to three years until they approach a desirable size. Then they are transplanted to so-called fattening areas of final conditioning preparatory to harvesting and marketing. Again experience has shown that oysters bedded in certain areas fatten quickly, and the growers use specific bars exclusively for that purpose. The oysters become plump and thick from the accumulation of glycogen, which is a carbohydrate, an animal starch, and increase in solid content. The yield and flavor

of edible meat from oysters are increased substantially by fattening and are important factors in the economics of the business.

It would appear that the Long Island grower has perfected his techniques, so that a minimum of scientific information is necessary. Actually, unless certain facts are determined, and relatively soon, by the ecologist, the industry there will be faced with difficult times.

Factors determining the magnitude of setting must be determined as soon as possible. In the past fifty years only eight or ten large commercial sets have been obtained. The entire industry, in New England and elsewhere, is dependent upon a consistent supply of good quality seed. The Long Island grower is a progressive oyster farmer. He does not plant his shells until the oysters have started to spawn. And yet he plants shells every year, since he needs a continuing source of seed, even though he knows the chances are not more than three or four in ten that he will secure a commercial set.

At this point the shellfish scientist becomes the key to future operations. His past studies have shown that spawning begins when temperatures reach a certain point—in Long Island at 16°–18° C, and in other, more southern areas at slightly higher temperatures. He has discovered that 12–15 days are required for the larval oyster to complete its metamorphosis, so that attachment can take place. Studies have revealed that setting is proportionately higher if the shells planted for cultch are relatively free of other marine organisms and other debris. Since setting of competing bryozoans, barnacles, and other marine forms takes place shortly before oyster attachment, the time interval for shell planting is greatly reduced. Most Northern planters delay shell planting until spawning has begun. It is then necessary to plant several hundred thousand bushels of shells in the two-week period before setting. The shells are washed overboard to distribute them on the bottom and to wash them free of any organic material or dirt that might reduce the surface available for setting.

In spite of all this care and precise operation, sets frequently do not materialize. The scientist is continually asked to determine the factors controlling the set, so that lack of set may be eliminated. If the answers were forthcoming, a set might be obtained in tanks or ponds under controlled conditions. Even though this would be expensive, it would not be as costly as continual failure to obtain sets from large-scale shell plantings in open waters.

The Long Island planter is cited to demonstrate the need for research on setting, since his plight is the most desperate. All areas north of North Carolina have some seed problems, but, if growers planting shells in public waters in Chesapeake Bay would use all the facts obtainable from the ecologist, setting failures would be reduced. Only in the area where the environment places rather rigid limitations on setting is more information vital to the industry.

If the Long Island planter is fortunate enough to obtain a set, it must subsequently be transplanted to the growing grounds. Until recently the growers allowed the seed to remain on the seed areas until the following spring, when the marketing season was about over, and then transplanted it. A few years ago marine biologists discovered that the mortality of seed left on the seed area until the following spring was often exceedingly high, and that there was considerable mortality as well in moving the set. If the set was transplanted in the fall, however, and spread rather thinly over the growing areas, the survival rate of the young oysters was increased. It is now a regular practice of many growers to transplant soon after setting, and, thanks to the biologist, the mortality has been reduced to a minimum.

A major problem of the grower in Long Island Sound and many other bays is the control of pests, particularly the oyster drill (*Urosalpinx cinerea*) and the starfishes *Asterias forbesi* and *A. vulgaris*. Huge losses are inflicted on the oysters, particularly in the first two years, by these predators. One Long Island grower has said that 50 per cent of any given set will be lost to these pests between setting and harvesting. So far, the ecologist has been unable substantially to reduce this mortality, although control practices developed by scientists are gradually being used. Any studies that will blueprint methods to suppress these natural enemies will make a substantial contribution to the industry.

Although private growers produce almost 50 per cent of the Eastern oysters grown in the United States, public acreage from Chesapeake Bay south represents the bulk of the oyster bottoms and offers the greatest potential. There are 50,000 acres of bottoms leased or owned in Connecticut, and in Maryland alone there are 265,000 acres of public oyster rocks. Since setting is naturally higher, the Maryland potential far exceeds that of Connecticut on a per acre basis, and thus in the aggregate. This does not mean a wide difference in production today. Connecticut produces about a million U. S. Standard grain bushels of oysters per year, and Maryland waters yield about 3 1/4 million bushels annually, about one fifth of the yield being on leased lands not included in the acreage mentioned above.

This low per acre production is the result of a public operation with very limited culture in Maryland as contrasted with intensive cultivation in Connecticut. The difference is most surprising, because the natural setting is so much higher in the more southern waters.

The possibilities for assistance to industry in Chesapeake Bay are probably even greater than in Long Island Sound, since cultural practices are relatively unused. Oyster research has been in progress in Maryland for thirty-five years or more, and yet only in recent years has the information been utilized to any great extent by the administrators of the fisheries.

It is necessary to digress for a moment to explain how the oyster industry is operated in Maryland as contrasted with Connecticut. Maryland bars are highly productive areas that have continued to produce, even though mismanaged or, in most cases, not managed at all. Even with reduced brood stock and cultch for the larval attachment, sets of sufficient magnitude are obtained to permit continued harvesting by archaic methods. In Maryland the legal methods for harvesting oysters from public beds are sail dredging and hand tonging. The inefficiency of these gears has undoubtedly perpetuated the lack of a sound production program. Most of the bars are public domain, and any citizen can resort to them for a livelihood. Many restrictive laws have accumulated over the past seventy-five years to maintain brood stock and cultch and thus maintain productivity, with but limited success. The need to replace the shells, and other material on the bottom, for larval attachment, was early pointed out by ecologists, but only in the past twenty years has replacement been carried out. All culture on the public domain is controlled by the State Fisheries Commission. This cultural program has been inefficient and will continue to be as long as political pressures and patronage are permitted to exert their influence. It is doubtful whether top utilization of all facts available could be obtained, even if culture is removed from politics by some administrative device.

This discussion of administration is brought in merely to show that the marine ecologist has an important position in state as well as in private oyster farming.

Actually, the state of Maryland is the biggest oyster farming unit in the United States, planting about a million bushels of shells and 300,000 bushels of seed annually. The Maryland shellfish culturist is attempting to plant shells as near to the time of spawning as possible to utilize fully the clean shells. The Chesapeake Bay scientists have ample demonstration of the increased yields when that is done. Some experiments have shown three times as many oysters per shell face in plantings just prior to setting, as compared to plantings made two or three months before setting would occur. In practically every case, even on commercial plantings by the state, the set is highest on those shells planted after spawning begins. The studies of ecologists have shifted the procedures used by Maryland to obtain seed. Not too many years ago shells were planted from January to April, when cheap labor was available, even though spawning does not normally begin until July. Today no shell plantings are made before May 1, and the bulk of the cultch is placed overboard in June. This culture is not as precise as that practiced by the planter, but it has increased manyfold the efficiency of shells planted.

The state and the grower would still like to know ahead of time whether conditions are proper for a set. If the ecologists could predict six weeks in advance that there would be no commercial set, many thousands of dollars could be saved by state and private growers by eliminating large-scale shell plantings for a given year. Here we come right back to the basic problem of determining the factors controlling setting.

The very size of Maryland oyster bars presents many problems. A critical study is needed to determine the environment for setting, growing, and fattening. Although many areas are known, from accumulated experience or careful scientific studies, to be suitable for one or the other of these processes, there are vast acreages that have not been critically examined. Some of the seed areas used by the state today were first discovered as high setting areas by scientific experiments. Before all the state bars can be utilized to their fullest potential, scientists should evaluate their use from the environmental conditions.

An oyster high in glycogen and solid content may be the difference between profit and loss to the oysterman. Whether a bushel of oysters will shuck six or eight pints is of vital importance. Are the best grounds being used for fattening? In the Long Island area long experience and trial and error by the growers have developed a pattern, but Maryland bars have not been classified except in isolated cases. Preliminary studies just published have shown that the mussel (*Brachiodontus recurvus*), which lives on oyster bars in close association with oysters, does reduce the yield of pounds of meat per bushel when it increases beyond a certain point. This mussel in these brackish waters attaches itself directly to the oyster by means of its byssus, and it frequently has been observed almost completely enveloping the oyster. These studies indicate that control of mussels alone might increase yields by as

much as 25 per cent on certain bars. Each separate oyster bar becomes a distinct study, if all the conditions are to be properly evaluated. It has been said that scientists have sufficient facts to increase oyster production threefold, if their knowledge were applied. There is little doubt of the truth of the statement.

Oysters have the highest glycogen and solid content during late fall and winter months in the more northern areas, but setting is limited. On the other hand, setting is so intensive in bays and sounds from North Carolina to Florida that the more desirable market product can be grown only with great difficulty. Science may show us eventually that seed should be produced in the Southern states, grown in Chesapeake Bay, and ultimately fattened in Long Island Sound. Careful studies are in progress now on just such a procedure. All attempts at transplanting on a large scale have failed thus far because of excessive mortality. If science can assure survival, the methods of oyster farming may be revolutionized.

Selective breeding may be another answer to the problem of survival, growth, and fattening. When one looks at the advances made in agriculture in grains, grasses, and livestock, there is every reason to believe that similar attainments can be expected in the oyster industry. Faster growing and fattening strains do not appear to be impossible objectives, although a marine animal with a three-year life cycle does present difficult research problems. Breeding experiments are of necessity long-term projects, but the objective is worth while. So far, little has been attempted, and only one such experiment is in progress on the Gulf Coast.

This is not intended to belittle the contribution of the scientist to the oyster industry. Indeed, it would appear that shellfish ecologists have done more to benefit industry than marine scientists have accomplished on any other brackish or marine species. Industry has been slow to adopt new methods, however, partly because there was a successful business without change, and partly because scientists have not always made their knowledge readily available to industry. It is hoped that future oyster-growing operations will integrate science, experience, and engineering as successfully as some of our major national corporations. Education and practical demonstrations are needed before the entire industry will accept the scientist wholeheartedly as a silent partner.

Game Conservation and Ecology

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EFFICIENCY in administration is attained through well-established routine. Frequent change disrupts routine, adds confusion, and increases work. The administrator hates change. The ecologist deals in change. This conflict in basic concepts presents a problem that can be solved only by shrewd salesmanship on the part of the ecologist.

A number of years ago, while working as a state game biologist, I found a sharp conflict between the research division and the administrators. The latter claimed the biologists were not obtaining the information needed in management. The biologists cried that the administrator never indicated what information he wanted; therefore, how could they get it for him? At the time, I was of course in sympathy with the biologists. Now I am sure the dissatisfaction of the administrators was justified.

If the biologist and, more especially, the ecologist, are to find their places in the sun, they must do much more than sit and wait for instructions from the administrator. They must know much more than ecology and biology. They must recognize the basic problems in conservation that constantly plague the administrator. They must develop a plan for solving these problems and, finally, they must sell their plan to the administrator. This final step, selling the plan to the administrator, is where the scientist frequently falls flat on his face. Because this selling job is a major obstacle, and one that is retarding the advancement of science, it may be well to dwell on it.

As in all salesmanship, the approach must be keyed to fit the audience. Not all administrators are cut from the same pattern. It is seldom wise, however, to dwell on methods and techniques. Such an approach leads to questions that appear stupid to the scientist and to answers that sound even more stupid to the administrator.

Monetary value, like music, is a universal language, the language that must be used in selling

a research program. It may be necessary for the ecologist to say it will cost $20,000 a year for five years, or $100,000 to obtain the desired information. This may be followed by saying that there is a 50–50 chance that the work will not be successful, so the cost should be estimated at $200,000. If the ecologist can then show that the answers he seeks will, when applied in a management program, be worth more than the cost, he will probably find the administrators ready to gamble on his work.

Eventually experience teaches us, if we are at all capable of learning, that the research assumed to be the most practical is likely to be more expensive and less productive than the so-called impractical research—the mere seeking of truth for the sake of knowing. The well-defined objective remains out of reach while the silly tangent reveals something basic. This is not always the case, but it happens frequently enough to recommend a relatively free rein on the researcher. I have long been an advocate of practical wildlife research. It has been my most productive form of stupidity. I highly recommend it to those who must sell research programs to hard-headed adminstrators.

The need for a definite objective in conducting an ecological study may be debatable, but the need for a definite objective in selling the study to administrators is nondebatable.

We know very little about the habitat requirements of upland game and we know even less about waterfowl needs. Last July I spent three weeks on a waterfowl study at The Pas, Manitoba, where I learned at least two things: First, compared to the prairie potholes, The Pas has been overrated as a duck factory; second, the duck and I could not agree on what constitutes good habitat. Vast areas of apparently good habitat are virtually unoccupied. It is discouraging to learn that you are dumber than a duck—but are the ecologists smarter? Can the ecologist identify, define, and classify duck habitat? If he can, he should, because so far he hasn't.

While I was flying over western South Dakota on a commercial airline, my seat companion turned out to be the president of a Wisconsin sportsman's club. When he learned my occupation, I was immediately criticized for working for the South Dakota organization which discriminated against nonresident duck hunters. To keep the conversation interesting, I argued for the other side and asked him to look down and try to count all the stock dams he saw. I told him that South Dakota raised as many ducks on these 50,000 man-made water areas as her sportsmen shot. But to a Wisconsin sportsman this was sheer nonsense. He assured me that no self-respecting duck would even sit on one of those little mudholes.

Each man's concept of duck habitat is limited by his training and experience, and only the duck really knows what it wants. Yet progress in waterfowl management is blocked for want of a comprehensive system of water classification. How can we create duck habitat when we cannot even recognize it without the aid of a duck sitting on it?

Given sufficient time and opportunity, I believe the ecologist can acquire the knowledge of a duck. I believe he can learn to evaluate and classify duck habitat throughout the continent. This is a big undertaking because habitat requirements vary with species, sex, and season. Further, the ecologist can prescribe remedies for marginal habitat, determine the relationship between ground water and surface water, and eventually set forth a long-range plan that will secure waterfowl habitat throughout wet cycles and periods of drought.

A survey to unravel these and all the other mysteries shrouding the relationship of a duck to his environment is no one-man undertaking. It calls for a well-equipped team of scientists, each man an expert in his field. This team should include men in the fields of geology, soils, chemistry, vertebrate and invertebrate zoology, ecology, agricultural economy, and possibly others. Such a study sounds like an expensive undertaking, but compared to the cost of so-called action programs the cost would be trifling. The accomplishments of such a study would be meager indeed if they did not outweigh the benefits of many action or development projects. Such an environmental study, which we might label the ecologist's dream, will not easily be sold to the administrator. The reason is that the administrator will have difficulty selling it to the sporting public with whom he must deal.

The average sportsman, God bless him, loudly proclaims that his interest is in perpetuating duck hunting for posterity in general, and for his kids in particular. In this he is largely sincere, but somehow a plan that promises more ducks in the air after his seventieth birthday does not get the support of a scheme that promises more birds in the bag next fall.

If the ecologist is to get the opportunity to show his wares, he must not only sell them to the administrator, but he must provide the administrator with the ammunition necessary to sell his ideas to the public. And it may be that such ammunition must include a detonator that will explode and expose the schemes that attempt to improve en-

vironments without a knowledge of waterfowl needs. Environmental controls can be effective only after we have learned to recognize and supplement limiting factors. In upland game management, it is not difficult to create a nesting or resting area that will lure birds in at the expense of some other piece of habitat, but this is no assurance that anything is being contributed to the total population. Is it possible that this principle also applies to the development of waterfowl habitat? Some progress is being made. The aerial breeding ground survey is developing into a valuable census technique, and some of the new men in the field are exploring basic concepts.

A short time ago, in working up a report, some facts relative to duck production were needed. The answers, when finally located, were not found in the published works of the old masters or in the literature of conservation agencies, but in thesis material of University of Minnesota students. The work done by Charles Evans in Manitoba and I. G. Bue in South Dakota provided the answers. This is an encouraging sign. It is also encouraging to see state conservation agencies taking a more active part in waterfowl research. It was natural that states should direct their first research toward the solution of resident game problems, leaving the work on migratory species to be done by someone else. It is becoming more evident, however, that as a state benefits from migratory species, it should contribute to the gathering of facts that lead to the best possible management. It must also be recognized that, under the excellent Pittman-Robertson program, many states have developed very good research teams.

The multimillion-dollar waterfowl industry must not rely upon students gathering, in scattered bits, the basic knowledge so essential to its perpetuation. Can we organize powerful research teams? We can if we show the administrators and the public the need for basic knowledge. We must convince them that everything we do deals with ecology. The cloak of mystery must be removed. Three things must be made common knowledge: first, change is inevitable; second, it is possible to understand change; and third, when understood, it is possible to influence the direction of change.

Photo by E. P. Haddon, Fish and Wildlife Service

The Rise and Fall of a Reindeer Herd

VICTOR B. SCHEFFER

Dr. Scheffer's work in zoology is well known, for he has been biologist and project leader in charge of research, Alaskan Fur Seal Herd, Fish and Wildlife Service, since 1940. In a technical paper in SCIENCE (**112**, *309 [1950]*), *he described some of the details of his research. On canine teeth taken from 75 fur seals of known age, growth layers accurately represented the age up to four years, and occasionally up to seven or eight, but tended to give false evidence above age four, largely owing to the variable rate of growth of the animal. Four years ago,* THE SCIENTIFIC MONTHLY *published his "Mystery of the Mima Mounds," those strange hummocks scattered by the countless thousands over the Western states from the Mexican border to northern Washington.*

IN THE fall of 1911 the United States government placed 40 reindeer on the Pribilof Islands, Alaska, to provide the native residents with a sustained source of fresh meat. The deer were descendants of stock imported by Sheldon Jackson from Siberia in the period 1892–1902 and placed at Teller, Alaska, from whence some were moved to Unalakleet and, finally, via the revenue cutter *Bear*, to the Pribilofs.[1, 2] Four bucks and 21 does were landed on St. Paul, and three bucks and 12 does were landed on St. George, the neighboring island forty-one miles to the south. Along with each group went an Eskimo herder to instruct the Pribilof Islanders in the handling of reindeer. The plantings were an immediate success, for in the following spring, 17 fawns were born on St. Paul and 11 on St. George.

The population records of the Pribilof herds since 1911 are of considerable interest to the student of wildlife behavior. In a sense, the Pribilof Islands have served as an outdoor laboratory where the deer have been held under observation for forty years. During this period they have been maintained in a semiwilderness environment, subjected to little hunting pressure. They have been completely free of attack by predators, for the only land carnivores on the islands are foxes and domestic cats. As G. Dallas Hanna[3] predicted in 1922, "It would seem that here is the place to maintain model reindeer herds and to determine many of the needed facts for the propagation of these animals on a large scale. At no other place are conditions so favorable."

But the trends of the reindeer populations since 1911 have been disappointing (Table 1 and Fig. 1). When Hanna published his report in 1922, the St. George herd had already reached its ceiling of 222 members, and was soon to subside to a small, stable population numbering 40 to 60. The St. Paul herd grew slowly and steadily until the early 1930s, when it suddenly erupted. By 1938 it included more than 2,000 animals—twelve years later only 8! (Estimates of the number are accurate to within about 10 per cent. An inventory is taken annually in the fall of the year by government employees, who scan the treeless tundra from the tops of low, volcanic hills.)

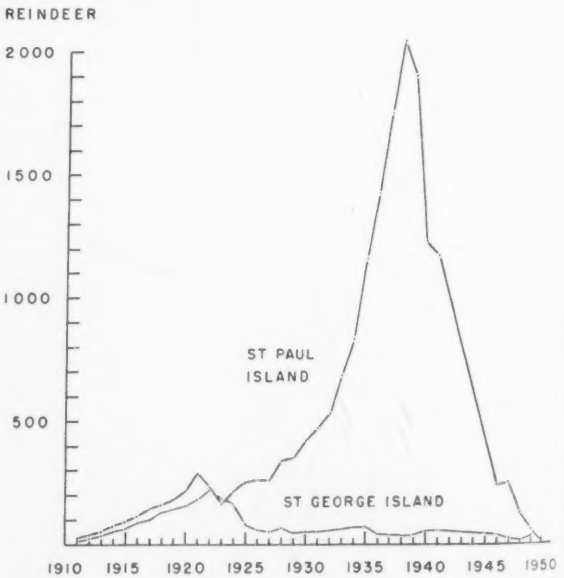

FIG. 1. Reindeer populations of the Pribilof Islands from 1911 to 1950. (Each point represents the combined number of deer killed for food and spared or, in years when no animals were killed, the number of deer counted at the end of the year. From Table 1.)

TABLE 1

THE REINDEER POPULATIONS OF THE PRIBILOF ISLANDS, 1911–50: NUMBERS KILLED ANNUALLY FOR FOOD AND NUMBERS SPARED*

YEAR	ST. PAUL ISLAND		TOTAL	ST. GEORGE ISLAND		TOTAL
	KILLED	SPARED		KILLED	SPARED	
1911		25	25		15	15
1912		40	40		25	25
1913		52	52		38	38
1914		75	75		58	58
1915		92	92		62	62
1916		111	111	2	85	87
1917		144	144	3	93	96
1918	2	155	157	18	114	132
1919	14	164	178	22	123	145
1920	22	192	214	31	125	156
1921	34	250	284	19	160	179
1922	38	190	228	22	200	222
1923	14	150	164	34	145	179
1924	13	200	213	18	150	168
1925	25	225	250	17	60	77
1926	10	250	260	10	50	60
1927	9	250	259		50	50
1928	22	315	337		66	66
1929	20	329	349		45	45
1930	17	404	421		51	51
1931	19	453	472	5	47	52
1932	47	485	532		57	57
1933	11	673	684		63	63
1934	14	820	834		72	72
1935	23	1,162	1,185	3	71	74
1936	37	1,388	1,425		44	44
1937	80	1,673	1,753	8	32	40
1938	103	1,943	2,046		38	38
1939	105	1,800	1,905		42	42
1940	265	962	1,227		54	54
1941	326	850	1,176	3	53	56
1942						
1943						
1944						
1945	56				41	41
1946		240	240		38	38
1947		250	250		20	20
1948		120	120		10	10
1949		60	60		30	30
1950		8	8			

* Data from published annual reports of the Alaska fur-seal industry and manuscript reports of the Fish and Wildlife Service. The data are incomplete for the war years 1942–45.

Several thoughts come to mind immediately. Why was there an abrupt rise and then a fall in the size of the St. Paul herd? What ecological, or perhaps genetic, factors were responsible for the fluctuation? Why does the pattern differ on St. Paul and St. George, two islands within a few miles of each other?

The St. Paul Herd

As compared to that of St. George, the fluctuation of the St. Paul herd has been more pronounced, thus throwing into sharper relief the underlying causes and permitting a clearer interpretation of them. Observations on St. Paul over the period 1940 to 1950 and examination of the records point to the inescapable conclusion that the lichen flora of the island is the key to the behavior of the herd. Certain lichens, chiefly the taller, shrublike forms of *Cladonia* and *Cetraria*, serve as emergency rations for reindeer. From Palmer's long experience in the study of the arctic tundra, he concludes that

> Although the lichens can not be said to be necessary for reindeer maintenance because of their nature or nutritive qualities, yet from the standpoint of a readily accessible winter food supply they are essential. The animals

seem to be able to detect lichens through as much as four feet of loose snow and reach them by pawing. Experimentally, when offered other winter foods in addition to lichens, the reindeer took the lichens in preference.[4] During the main winter period, December 20 to April 8, a lichen forage is necessary. Desirable forage at this time consists of 75 to 90 per cent lichens and other vegetation, including mosses.[5]

When the St. Paul herd was small, numbering in the hundreds only, growth of the food lichens kept pace with the demand.[3] The food lichens are now so rare, except on Sea Lion Neck and around the village—both places where the deer seldom venture—that diligent search is required to find representative specimens. Biologist Ford Wilke found that in late November 1942 "grasses appeared to make up the bulk of the contents of two stomachs we opened. The lichen commonly called reindeer moss is practically gone from the island. . . . None was seen in the stomachs (*in litt.*)."

From about the first of May to late November, depending upon the weather, there is sufficient food in the form of grasses and other flowering plants to carry the deer along. For example, in June the deer feed extensively on the common umbellifer, *Coelopleurum gmelini,* and the fernleaf, *Pedicularis verticillata.* During a slaughter of deer in late August, several stomachs examined were filled with fibers of the abundant grass *Elymus mollis,* which gives to St. Paul Island its bright green color; also fibers of crowberry, *Empetrum nigrum.*

TABLE 2

SELECTED TEMPERATURE RECORDS FOR ST. PAUL ISLAND, ALASKA, 1926–50*

YEAR	MEAN TEMPERATURES		LOWEST TEMPERATURE	DATE
	JANUARY–MARCH†	ANNUAL		
1926	26.0	37.6	7	Feb 23
1927	24.4	33.6	– 4	Mar 19
1928	24.6	33.1	– 2	" 27
1929	29.0	36.8	2	" 15
1930	25.8	34.8	1	" 17
1931	23.1	35.3	1	Feb 21
1932	26.7	36.0	4	" 22
1933	24.1	34.7	– 15	Mar 15
1934	21.0	35.4	– 7	" 2
1935	30.5	38.5	5	Feb 11
1936	25.1	37.2	– 2	Jan 16
1937	33.6	38.9	8	Dec 11
1938	22.3	34.5	– 7	Mar 24
1939	24.3	33.7	– 1	Jan 22
1940	18.2	33.8	– 7	Feb 13
1941	23.0		– 6	Mar 7
1946	19.6	32.4	– 6	Feb 27
1947	20.8	33.2	– 17	Mar 12
1948	21.9	33.4	– 6	" 6
1949	26.4	34.9	0	Feb 9
1950	27.7	35.9	11	" 23
Mean	24.67	35.2	– 2	" 24

* From U. S. Weather Bureau, annual climatological data, Alaska section; records lacking from 1942 to 1945 because of war.
† Simple mean of the 3 mean monthly temperatures.

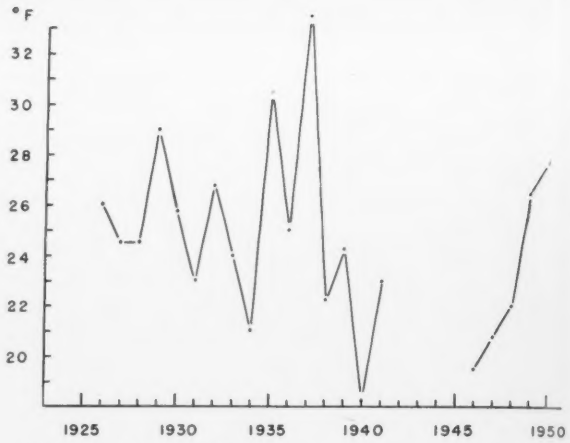

FIG. 2. Mean midwinter temperatures on St. Paul Island, 1926–50. (January, February, and March; from Table 2.)

How long will it take for the food lichens to recover on St. Paul? Hanna[3] believes that on the Pribilof Islands they grow more rapidly than on the mainland. "Areas completely denuded in 1914 were regrown by 1919. The difference in rate of growth is believed to be due to the longer growing season . . . and the much damper climate." But Palmer[5] states that "quadrat observations made on the coastal tundras indicate that recovery of lichen range following full cropping may take possibly 15 or 20 years," and "on an average range 33 acres is the minimum year-long grazing area requirement for each reindeer." The land area of St. Paul Island is 26,500 acres, which means that, at the peak of the population in 1938, there were only 13 acres of land for each deer, or actually about 11 acres of suitable grazing land. On this basis, *the reindeer population was at least three times the carrying capacity of the range.*

With the disappearance of the lichens the reindeer were left with inadequate winter food reserves. The year 1938 inaugurated a four-year cycle when midwinter temperatures fell below normal; the winter of 1940 was exceptionally cold (Table 2 and Fig. 2). According to the island records, in 1940 a crust of glare ice remained on the snow for several weeks, hindering the deer in their efforts to browse. Roger Chute, storekeeper, made a reconnaissance of the island between April 17 and May 9 and reported about 150 deer carcasses, most of them females and young. "Great acreages of interior highland grazing land, rich in

FIG. 3. The rolling tundra of St. Paul Island, studded with old volcanic craters (June 1940).

standing grass hay, have been abandoned by the deer herd throughout all the winter (*in litt.*)." (In our experience of ten years there has always been an abundance of *Elymus* on the Pribilofs. The availability of this grass, rather than the amount, is the critical factor.) Palmer[5] has cautioned that "because of winter rains . . . certain areas near the coast are subject to crusting, and under such conditions herds may suffer great losses through starvation, since the animals cannot paw through hard crust to get food."

Although the combination of depleted range and adverse weather seems clearly to have been responsible for the decline of the herd in the 1940s, the importance of other factors must be weighed (Figs. 3–6). The first of these is hunting by man. In 1942 the 500 residents of the Pribilof Islands were evacuated to southeast Alaska as a military measure and were returned in the summer of 1944. In the interim, troops were stationed on the islands. Quite naturally, no one paid serious attention to the reindeer herd on St. Paul until 1946, when an inventory revealed the dismaying total of 240 animals. Since the herd declined rapidly in the period of military occupation, some residents of the island believe that poaching was a major cause. But the form of the growth curve of the herd is clear evidence that the decline was well under way before 1942 and that it continued after 1944. In other words, we do not need the segment of the curve between 1942 and 1944 to enable us to recognize a familiar pattern. In their study of the population dynamics of the fruit fly, Chiang and Hodson[6] discuss the type of growth curve exemplified by the St. Paul herd.

> A population in a limited environment may increase in a logistic fashion, but, unless [it is] properly adjusted to the environment the fluctuation around the asymptote will be very brief or even be lacking, and a crash will immediately follow the production of the maximum population. This crash is a result, mainly, of the fact that the production of even one generation beyond a certain critical population level overshoots the maximum capacity which the environment can support.

The government made a serious effort in 1940 and 1941 to reduce the size of the herd by doubling and tripling the annual kill (Table 1, Figs. 7–9). So

FIG. 4. Three-year-old male reindeer tamed by the villagers of St. Paul (August 1946).

FIG. 5. Reindeer corral about 5 feet high and 40 feet in diameter, built of stones by an Eskimo herder on St. George Island and later abandoned (July 1940).

great was the momentum of the natural factors operating against the herd, however, that the decline continued almost to the zero point, even after killing was suspended in 1945.

Disease, the familiar sequel to starvation, has undoubtedly contributed to the decline of the herd. There is no evidence, though, that it has at any time become epizootic. Inbreeding, a scapegoat commonly used by sportsmen when faced with a dwindling population of big game, has also been accused of destroying the St. Paul herd. It might be pointed out that on the rugged Pribilofs only the fit survive. The occasional weakling developed through an accident of ancestry has little chance to live long enough to perpetuate his kind. Fighting, accidental deaths, and unfavorable sex ratios—these have also played their part. In the last analysis, however, *overpopulation* is primarily responsible for the type of growth curve with which we are dealing.

FIG. 6. Evidence of winter mortality on St. Paul Island (July 1940).

At this point it is timely to mention a resolution passed at the thirtieth annual meeting of the American Society of Mammalogists in 1950.

> [The Society] urges that the Canadian Government not undertake the introduction of reindeer into Ungava. Before any introduction is seriously considered, those persons involved in any planning are urged to make a thorough study beforehand of the problems of integrating lichen ecology, reindeer biology, and native culture—serious problems that have not been solved to date on any workable scale on the North American continent. It would be particularly deplorable if an introduction, to aid the natives, led to early successes and high hopes, then eventual failure.[7]

The St. George Herd

Over a twenty-five-year period, and with little interference from man, the St. George herd has fluctuated slowly between 10 and 74 animals. For unknown reasons the population has not erupted like the one on St. Paul. The area of the island is 22,400 acres, and at no time has the population exceeded one deer to 100 acres. Food lichens are still present in fair amounts. We can only point to cer-

FIG. 7. A reindeer roundup on St. Paul Island, August 1940. Men are driving the frightened animals into a corral (not shown).

FIG. 8. Butchering reindeer for the use of natives, St. Paul Island (August 1940).

FIG. 9. Reindeer in a corral at butchering time, St. Paul Island (August 1940).

tain ecological differences between the two islands and trust that somewhere among them lies the answer.

The most conspicuous difference is the far greater proportion of shoreline cliffs on St. George Island. Some of these drop almost vertically for 900 feet into the sea. Since reindeer habitually feed upwind, it is easily imaginable that individuals in the leading ranks might press into the face of a blizzard and go blindly over the edge of a cliff.

Again, the two islands lie on a critical line between Arctic Ocean and North Pacific influences, where slight discrepancies in weather conditions and ocean temperatures bring about noticeable differences in the fauna and flora. The mean southern limit of the arctic drift ice lies midway between the islands. The climate is slightly warmer, and the tundra is wetter on St. George. Certain flowers characteristic of the Aleutian chain (e.g., *Anemone narcissiflora* and *Fritillaria camschatcensis*) are common on St. George but rare on St. Paul. The bumblebee, *Bremus kincaidi,* is confined to St. Paul. The winter wren, *Nannus hiemalis,* is abundant on St. George but is almost never seen on St. Paul. The lemming, *Lemmus nigripes,* is limited to St. George, and the shrew, *Sorex alascensis pribilofensis,* to St. Paul. Whether the environment of St. George has "dampened" the fluctuation of the deer population remains an interesting but unanswered question.

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SMO ON THE AIR

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A Biologic View of Human History

BENTLEY GLASS

Asked to review the Seidenberg book for The Scientific Monthly, *Bentley Glass found himself getting more and more deeply involved in his evaluation, until at last he decided he could not express his opinion in less than several thousand words more than the conventional review. The article below is the result. Born in Laichowfu, Shantung, China, Dr. Glass, who took his Ph.D. in biology at the University of Texas in 1932, is one of the original members of the AAAS Editorial Board. He has been assistant and associate editor of the* Quarterly Review of Biology *since 1944 and a member of the faculty of The Johns Hopkins University since 1947.*

UNDER the arresting title of *Posthistoric Man*,* a new, all-inclusive view of human history has been sketched as an alternative to the monumental structures of Spengler, Pareto, and Toynbee. In some respects the new work enlarges upon the plan of Carl Becker's brilliant, all-too-brief essay upon the theme of *Progress and Power*. In other respects Roderick Seidenberg, the author of *Posthistoric Man*, acknowledges his debt both to Spengler and to Toynbee. Seidenberg, however, is no mere eclectic, but a true original. Where Spengler and Toynbee alike show weakness—the former in antipathy toward science and the latter in overcredulous acceptance of Ellsworth Huntington's doctrine of "climate and culture" mingled with the inheritance of acquired characteristics—Seidenberg's thought is broadly based in scientific knowledge. At the very core of his thinking lie the second law of thermodynamics and the theory of organic evolution. Hence it is to Henry Adams that Seidenberg is most of all indebted, since it was Adams who struggled to define the "tendency of history" and who dared to probe the conflict between the inevitable increase of entropy and the theory of indefinite human progress. Not that Seidenberg is so naïve in this respect as Henry Adams, in the early years of this century. Time is recognized to be of the essence in this irreconcilable clash of principles, and Seidenberg is sufficiently aware that if organic evolution can counter the tide for some hundreds of millions of years there is no reason why human history might not form a lesser eddy. The ultimate task of the historian, seen in this light, is therefore not so much to describe the cyclical growth and decline of individual cultures and civilizations, as rather to define the causes which govern historical development and to determine their laws, even as a biologist studies the genes that govern the development of the individual, and the interactions of natural selection and other agencies that determine the evolution of the species.

* *Posthistoric Man*. Roderick Seidenberg. x + 246 pp. $3.50. University of North Carolina Press, Chapel Hill. 1950.

The Trend of History

This is a praiseworthy aim, and the analysis is straightforward and logical. It is therefore the author's basic assumptions that are all-important. Before examining these, however, it will be necessary to trace his general line of thought. One starts from the observation that there is a trend toward increased organization manifested everywhere in human affairs. Organization is the conscious construction that marshals our means toward the achievement of explicit ends. It is a "mesh, an ever expanding trellis, along which civilization expands and develops . . . an ever more comprehensive and explicit series of channels, so to speak, through which man's aims, efforts, and impulses are increasingly integrated." Collectivism is but the social application of organization, the machine its index. Thus mankind drifts "from *unconscious participation* in the accepted rituals and dogmas of primitive life toward an ever more *conscious conversion* of their form

and substance into the rationalized and purposive institutions of civilized society." "Organization demands further organization;" "order demands order." Thence arises the "grain to the texture of events, the significant direction to the course of human development . . . the undeniable drift of historic forces toward a more crystallized status of man!" This trend of history manifests the increasing, though still far from complete, dominance in man of the intelligence over the instincts which governed his behavior in preconscious times. "For his instincts and his intelligence, however he contrived to hitch them together, were not set to go in the same direction. That is the crucial fact of his history. Their relation, their eternal conflict in all its diverse facets, might be said to constitute his history—the endless search for new forms within which they might be harnessed in some happy equilibrium."

The struggle, however, is unequal. Intelligence comes increasingly to dominate, until "man, the puppet, animated from within by the hand of instinct, becomes a marionette controlled from without by the compulsions of intelligence." For, inescapably, "to the degree in which he comes to adjust his ways of life to the unchanging verities of these laws of nature, he will approach fixed perimeters in his future development." History is envisoned, then, as the "Crucial Epoch" of conflict between instinct and intelligence, a period of transition from the dominance of the former to the dominance of the latter, a crux in the existence of mankind. Seidenberg regards culture as resting "upon the hope of attaining . . . a living synthesis of instinct and intelligence." Man, however, has pragmatically elected to develop his civilization at the expense of his culture. The choice was not made in full awareness. Man altered "not so much his distant goals and basic desires as his method of approach to these ends." "It was not his choice but rather his fate that intelligence should in time supersede the instincts as the dominant directive force in his affairs. And this change, by virtue of its comprehensive scope, its inherent necessity, and its irreversible drift, must be acknowledged as evidence of an inescapable *historic determinism.*"

In discussing his doctrine of historic determinism, Seidenberg is at his most brilliant. Here he considers the relation of the second law of thermodynamics to life, to the problem of organization in living systems, and particularly to organic evolution. He draws copiously for the support and clarification of his ideas from the writings of H. J. Muller, Joseph Needham, Harold F. Blum, R. S. Lillie, Alfred J. Lotka, and numerous other biologists, as well as physical scientists. He is especially impressed by the irreversibility of process seen alike in the increase of entropy and in evolutionary change. He develops at some length an analogy between human history and the behavior of physicochemical systems, provisionally equating "the individual with the random molecule; the machine with the crystal; society as an organized entity with a physicochemical system having a crystal structure; and finally, a basic change of historic direction with a thermodynamic change of phase." Historic determinism, in other words, interprets the dynamics of human history as a change of phase like that occurring when the disordered flux of molecules in a supersaturated solution is changed to the highly organized state of a crystal. In this change the machine plays the part of the crystal introduced to seed the change of phase and initiate the rapid crystallization of the entire system. Like all reasoning by analogy, this can be pushed too far. Society is obviously *not* simply a physicochemical system, and this analogy is even wider than the comparison of a society composed of individuals and an organism composed of cells. Yet an analogy can be helpful in clarification, and it should be emphasized that this one is not an essential part of the author's logical framework.

In the last chapter, Values and Vistas, there is foreseen a day when the organization of society will have proceeded to its final crystallization, when, "in a period devoid of change, we may truly say that man will enter upon a posthistoric age in which, perhaps, he will remain encased in an endless routine and sequence of events, not unlike that of the ants, the bees, and the termites. . . . Man may likewise find himself entombed in a perpetual round of perfectly adjusted responses." Any application of eugenics to the human species is far more likely to hasten the trend toward social crystallization than to counteract it, since the measures of eugenics will set limits to genetic variability and enhance the uniformity of the genotype. "Man will hasten along his predestined way under the illusion of attaining his freedom on even higher levels of existence, while actually sealing his fate by all the devices his dominant intelligence can command." The emotions will have atrophied, and even consciousness, no longer necessary in the absence of tension or unstable equilibrium, will evaporate and disappear. Is this mere fantasy? Is one reminded of George Orwell's repugnant picture of *1984*? The question simply reduces itself, says Seidenberg, to the alternative of limited or of unlimited progress, biologically speaking. A sane and scientific view will regard the former as more probable. Science

itself must move along an asymptotic curve as knowledge of our universe and its laws becomes more and more complete, for is the universe not finite and are its laws not numbered? There will come an era of diminishing returns as science, too, becomes "involved in the decisive struggle between the dying ideal of the 'intrinsic superiority' of the individual and his absorption and subordination within the dominant collectivity." The range of values will be constricted to conform "with the ideality of the community rather than with that of the individual." The Great Tradition upon which Western society has been nurtured, the conception of the "infinite worth of the individual," of "the purposeful freedom of the human soul," seems already to have slipped away, beyond recall. "If society once drew strength and sustenance from the inner sources of being through the revelations of saint and mystic, it seems destined to abandon this well of inspiration in focusing wholly upon the external manipulation of its affairs and the purely mundane solution of its problems." The great "Person" whose creative personality saves and transforms mankind will be increasingly less likely to appear in the ordered society of the future on account of its "drastic suppression of all deviations from the dominant norm." The salvation of the person is being replaced in the system by the security and welfare of the collective individual. "In this mechanization of society and dehumanization of the individual we cannot fail to see the eclipse of the spiritual structure of man." From the ultimate stabilization of human relationships man cannot escape. Perhaps he may be able to slow the evolutionary process, but he can never alter its direction. The merciless pressure of intelligence must lead man at length to "the icy fixity of his final state in a posthistoric age."

This somber picture of human history possesses a strange grandeur. One senses that the author himself would not have it so, would much prefer Toynbee's Civitas Dei and the creative love of humanity which Bergson emphasized as the mark of each great soul which lifts mankind to a higher level of nobility and achievement. The renunciation being thus the greater, it partakes of the sadness of all lost illusions. Seidenberg is unquestionably a great master of language. One is soon overwhelmed by the memorable phrases that clothe the current of his thought, by the remorseless logic of clear and pregnant statement, by the epic development of his conception to its stark conclusion. Even while unconvinced, one is bereft of all faculty for criticism. It is necessary to wait until the glow of appreciation has somewhat waned, and to return with a more analytical eye. Then, and only then, the weaknesses in the structure become apparent.

True or False?

A number of the basic assumptions appear to be unsound. Consider first the question of the relation of organization to the existence of human freedom. Does the increasing trend toward organization, which obviously exists, necessarily lead to fixity of behavior and to limitation of choice? History itself provides an answer. Must one seriously conclude that modern man, with his complex social organization, is more restricted than primitive man in his freedom to act? The answer must clearly be negative, for the freedom to act and to choose itself depends upon knowledge and upon opportunity. Primitive man, loaded with tabus and hemmed in by superstitious fears, was freed by the advancement of knowledge. Science itself, by vastly enlarging the scope within which human choices can be made, has contributed basically to human freedom. As Lyman Bryson has put it, "No man is free to choose what he has never heard of." Granted that increasing organization restricts freedom of action in certain directions, the enlargement of freedom is always more than compensatory; or else intelligence itself would deny the merit of such organization. The point may be clarified by a simple and familiar example, that of the organization of the flow of traffic in an automotive age. The provision of traffic regulations and the installation of traffic signals to be obeyed of course limit the freedom of action of the driver of an automobile. Nonetheless, intelligent drivers gladly obey such regulations even when they are not enforced, for they know that in the absence of such organization of traffic their freedom to move in a chosen direction would be enormously more impeded by traffic jams and accidents. In this case the driver values the freedom to move with speed in a desired direction above the freedom to drive without consideration of other vehicles. In the preautomotive age such complex traffic regulations were quite unnecessary. Yet would anyone argue that the enlarged freedom of travel provided by the automobile has not more than compensated for the restrictions necessary to organize traffic?

A closely related question is the implication that the dominance of intelligence, when based upon sufficient knowledge of the laws of nature, will lead to as great a fixity of behavior and limitation of choice as the dominance of instinct. It should not be forgotten that intelligence has evolved among

animals as a mode of plastic response to the complexities of a varied and varying environment. The simple assumption of "the biologic priority of the instincts," made by Seidenberg, is not justified by biological evidence. Learning is present in even the simplest organisms, from the protozoan up the scale. Side by side with simple reflex and tropism is to be found the capacity for conditioning—that is, for modifying behavior in relation to past experience. Instincts of a more complex sort scarcely appear before worms and arthropods enter the scene, and even in these groups, where today instinct reaches its utmost heights, learning and a degree of intelligence are not altogether excluded. In the evolution of the vertebrate line, it would seem that instinct and intelligence were rather equally matched for some 400 million years, well into the Cenozoic era. In fact, in only two classes, the Aves and the Mammalia, has one come to predominate over the other. In the birds, the instincts now have the ascendance; in the mammals, the intelligence. Yet many birds have considerable intelligence, and many mammals obey strong instincts, such as to migrate seasonally or to hibernate, to bury nuts in the earth, or to herd together. In all species one finds a beautiful adjustment of instinct and intelligence to the needs of the organism in its prevailing environment. The formation of habits on the part of intelligent animals which have learned to respond in a certain way to chosen stimuli is also illuminating, for the existence of habit indicates the economy of having automatic responses to situations frequently met. In this, habit resembles instinct. Yet habit is most useful because it frees the intelligence from the need of attending to ordinary matters and allows it to be devoted to the exceptional, the novel, the changed in the environment. Since instinct merely carries this to the ultimate extreme of embedding the responses to the usual within the genic mechanism that controls normal development, instinct too can play a part in freeing the intelligence from attention to routine. Instinct and intelligence may indeed be harmoniously united.

The Evolution of Intelligence

The intelligence of man is an evolutionary product of natural selection for adaptability to great variation of surroundings, to tremendous vicissitudes of experience, as Bergson concluded forty years ago. It should follow from the nature of natural selection that the prolongation of the dominance of intelligence in man must depend upon the maintenance of the variety and richness, the vast complexity of that world to which he must adjust his ways. Herein lies the paradox. If, as Seidenberg supposes, the end of man is to crystallize his society so that nothing will ever happen but the ordained, and no choices will remain because knowledge and intelligence will demand only stereotyped responses, then the outcome must be the degeneration of intelligence. It will follow the oft-repeated pattern of the evolutionary degeneration of whatever structure has become useless—the eyes of the cave fish, the wings of the running birds, the legs of snakes, the muscles in the ear of man. True, evolution in the particular is irreversible, but not in a general sense. Land animals that descended from the lobe-finned fishes of the Paleozoic seas later returned to a marine existence, not in one only but in numerous instances. There is therefore no guarantee that organisms now intelligent and adaptable cannot revert to a life dominated by instinct and inflexible adaptation; but there is the strongest ground to doubt that intelligence could be maintained in a crystalline pattern of social existence. The crushing of scientific freedom in recent years in one after another of the totalitarian countries strongly supports this doubt.

That the organization of society might ever proceed to such an extent as to obviate the need for intelligence is, however, also greatly to be questioned upon several grounds. Is it not apparent that the increased complexity of a highly scientific civilization and a highly organized collective society must require of the individual more capacity to learn, rather than less? Does not the development of the infant, child, and youth already require a vastly greater educational endeavor than in primitive human society, and will this conceivably diminish as society becomes more complex? If the answer to these questions be affirmative, is it not equivalent to an admission that, in spite of the great increase in organization to be expected in the future evolution of society, the areas within which the individual may or must exercise choice will not be restricted to the point of elimination, but on the contrary will be enlarged? Is it not indeed to be expected, on the grounds of the calculus of probability, that the choices to be made by individuals will increase as a mathematical function of their opportunities, and these being enormously multiplied, that *more* rather than less intelligence will be demanded?

It would seem that the only alternative to the future enlargement of intelligent choice by the generality of mankind lies in a regression, in whole or in part, to the regulation of life by instinct and

emotion. It is highly doubtful, however, that the human species could evolve and perfect instincts adequate to cope with the complexities of the social organization now existing, before that social organization would have crumbled from the diminution of intelligence. There are some signs that we lack sufficient intelligence to maintain it even now. Any regression of intelligence is far more likely to bring the swift extinction of our species, leaving earth to be inherited by forms with already highly developed instincts, such as insects, or by those with a good balance of instincts and intelligence, such as birds or squirrels.

The crystallization of human society into a changeless rigidity dominated by reason armed with infinite scientific knowledge might have another outcome, rather often pictured by writers of science fiction. This envisages a fission of the human species into a ruling caste of a relatively few individuals, evolving higher and higher levels of intelligence, and a much more numerous helot or robot caste of workers, chained by their instincts and minimal intelligence to the performance of simple, mechanical tasks. How any such society could be achieved genetically is not often considered. The hereditary basis of intelligence is generally accepted to be multifactorial. As a consequence, the genotypes which underlie high intelligence and genius are most often produced sporadically by the random combination of genes present in parents of ordinary or somewhat above ordinary intelligence. Selection for high intelligence would take a very rigorous and long-continued program of selection, combined with an alternation of inbreeding to determine genotypes and of outcrossing to recombine the favorable genes from different strains. Moreover, the very possibility of selection for high intelligence would depend on the ability to meet two criteria which we are very far from being able to satisfy at the present time. First, it would be necessary to have tests that would accurately measure "intelligence," a capacity which until now it has been impossible even to define adequately. Second, it would be essential to know the precise nature of the environment regarded as the ultimate goal of society, inasmuch as intelligence is vastly affected by environmental factors, and the action of specific genes is by no means the same in different environments. If these difficulties are not sufficient to make the whole idea appear chimerical, it may be added that there are yet greater obstacles in the way.

For many generations, at least, mankind has favored outbreeding, the closest forms of inbreeding having been almost universally tabu. Within the past three centuries human populations have increased enormously in size, and an approach to panmixia has become characteristic of the major races of the world population. The result of this has been to render man a highly heterozygous animal. Beneath the façade of dominant traits (along with some homozygous recessives) expressed in the phenotype of each individual, there lies concealed a great number of unmanifested recessive genes, kept in a heterozygous condition in most possessors within the population. From studies of mutation in man, mouse, and *Drosophila* it is apparent that the manifestation of the majority of these recessives would be deleterious in most, if not all, environments. In fact, one fourth to one third of them are lethal when homozygous. New lethal and deleterious mutations arise in each generation at an average frequency that is estimated to be of the order of 10^{-5} per locus per gamete, or higher. The number of different genes (i.e., loci) in man may be taken as 10,000, or perhaps even 40,000.[1] It follows that at least 1 gamete in 10 will bear a new mutant, nearly always of a lethal or detrimental sort. The effect of these is not normally evident, since they are kept heterozygous. Any return of the human population to closer inbreeding may be expected, however, to bring these recessive traits to the surface. It should be apparent that any program of selection will have to be limited to a population of relatively small size, and inbreeding cannot be avoided, both for this reason and also because it is necessary to reveal the recessive genes that participate in the high development of the selected character. The result to be expected, therefore, is that progress toward a pure line of persons of high intelligence would be combined with the accumulation of numerous recessive traits of a detrimental nature. Very likely these could not be altogether eliminated. Like the inbred pure lines of maize from which our hybrid corn is derived, human pure lines selected for intelligence would most probably be weak in vigor, low in fertility, and beset by numerous hereditary defects, it being next to impossible to select for everything desirable at once.

Within the masses, on the contrary, the very size of the population would permit far more numerous mutations at all genetic loci, and consequently a far greater chance of occurrence of those rare, fortunate mutations which improve the adaptation and adaptability of a Mendelian population to its environment. There would also be far greater genetic recombination, yielding a vast variety of

genotypes to be tried out in the prevailing environment. The outcome can readily be seen. Given an environment of diversity and complexity, the evolution of intelligence should proceed. Slaves the masses might become, but robots never.

Changes of Environment

The crystallization of human society is a mirage on still another count. The story of evolution repeats through age-long cycles the stupendous alteration of the environment itself. Continents drift, or sink beneath the ocean; new lands emerge from watery depths. Mountain ranges are elevated to heights above Everest, and change the climate of lands to leeward and to windward. Ice-caps thousands of feet in thickness may cover much of a hemisphere. Erosion and weathering slowly but surely reduce the level of the land, and melting glaciers recede. Seas become shallower and climates warmer, while life, like a vast tide, ebbs and flows over the land surface and through the seas. Corals once lived in the waters of Greenland, and tropical coal forests clothed now icy Spitzbergen and Antarctica. We do not at present understand the causes of these great cycles that alter the earth as a habitat for life, but the evidence of their existence is undeniable. It is therefore crucial to the view of human history to remember that we live in the wake of an Ice Age scarcely departed—perhaps even in the interval of a few tens or hundreds of thousands of years between recurrent glacial epochs. A reminiscence of the history of man during Paleolithic and Neolithic times should sufficiently warn us that civilization is not made by man alone, but that society is forever constrained between the upper and nether millstones of climate and resources. The growth of scientific knowledge and the increase of power may well enable mankind to weather future crises, but surely not without changing and adapting his ways. Repeatedly in evolution highly adapted and specialized plant and animal species have been extinguished as the environment has shifted beyond their genetic capacity to change to meet the new conditions. The more adaptable, and usually less specialized, forms have survived to occupy the vacant stations, and in their turn to evolve, almost explosively, into new varieties of species specialized for all the ecological niches of the available environment. The most progressive line, because it is most adaptable without being overspecialized in any limiting way, is, as Julian Huxley[2, 3] has frequently stressed, the line leading to man. "Man stands alone" because of his adaptability, an adaptability that resides solely in the power of his intelligence. These can never become separated in human history. Posthistoric man, in Seidenberg's sense, can only perish.

A Contribution to Modern Thought

In spite of the profound differences between this view which I believe to be necessitated by biological fact, and the views advanced by Seidenberg, it is in the end needful to pay tribute to more than the power of his imagination and the memorable quality of his language. Like Bergson, whose views on evolutionary process are unacceptable to modern evolutionists but whose poetic concepts, and in particular whose appreciation of the consequences and corollaries of the evolutionary origin of mind, clarify and illuminate the major issues of evolutionary history, so Seidenberg has made an inestimable contribution to modern thought. He points the way to the development of a scientific theory of historic determinism, to a unification of physical and biological knowledge of the earth and of man with the philosophy of human history. He makes us conscious of the irreversible drift toward organization in the dynamics of human history, and particularly cognizant of the need to study the limits and outcome of such process. He has raised momentous questions for the consideration of historian and biologist alike. Our peril is not so much that he will lead us to wrong conclusions, but that these momentous questions he has raised may lack consideration, that biologist and historian, scientist and humanist, will pay them no heed.

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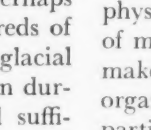


Wild Rice

EDWARD TAUBE

The author received his Ph.D. from the University of Wisconsin in 1935. His studies have taken him to Chicago and to Berlin, and he is now teaching geography at the University of Wisconsin Extension Center, Racine. The present article grew out of his interest in Wisconsin place names.

WILD rice, a characteristic product of the old Northwest, had a marked effect on Indian life at the headwaters of the Mississippi River and in the Great Lakes region. Growing in abundance along the marshy borders of most rivers and lakes, it gave nourishment to the Indians and the fur traders, and by fattening countless ducks and other game, it offered an additional, much-appreciated source of food.

Although it flourished in adjacent areas, the region now known as Wisconsin and Minnesota bore it with unusual luxuriance, thus becoming a center of Indian population, a veritable aboriginal Utopia. This was the wild rice district, the great wild rice country where *Zizania aquatica* L. was the most important cereal, more important than Indian corn.

What were once large fields have shrunk to the merest remnants or have vanished completely. Yet the former dominance of wild rice is still apparent on modern maps in the numerous lakes and streams called "Rice," or *manomin* ("wild rice"), or by an Indian word for knocking the kernels off the plant.

When the French missionaries came to Wisconsin almost three hundred years ago, they noticed that the Indians gathered a wild grain that had sprung from the muddy bottoms of the streams and marshes. They saw this valuable native grain not only along the Menominee River, which flows into Green Bay, but in other sections of the Upper Lakes as well, among the Sioux at the western end of Lake Superior, at Chequamegon Bay on the southern shores of Lake Superior, and particularly along the Fox River of Wisconsin.

In their letters the French missionaries praised the wild water plant that offered abundant crops of wholesome cereal, calling it "wild oats," not "wild rice." One said that the grain was both tasty and nutritious, a second regarded it when mixed with buffalo fat as the most delicate of native dishes, a third thought it better than Indian corn.

Father Marquette joined his fellow-missionaries in their praise; he said even more about it than they did. He and Joliet, bound for the Mississippi River, visited the Menominee Indians, who then lived along the northern shores of Green Bay. Just as some Americans later translated *Menominee* as "Wild Rice Men" or "Wild Rice Eaters," so Marquette and his countrymen usually spoke of them as the *Folles Avoines,* that being the French phrase for "wild oats." Telling in his journal about his stop on Green Bay, Father Marquette first of all made it clear that the Menominee Indians got their name from a plant looking very much like wild oats, and growing wild in the muddy bottoms of the rivers and marshes. Then he turned his attention to Menominee methods of harvesting, drying, cleaning, and storing, ending up with having wild rice taste almost as delicious as cultivated rice.

When the explorers came to the headwaters of the Fox River, shortly before reaching the portage to the Wisconsin River, the canoemen tugged and

Water feature names based on "rice" in Wisconsin and Minnesota, the region known to various writers as "wild rice district" or "great wild rice country." Each dot indicates a location such as "Rice Lake," "Big Rice Lake," "Wild Rice River," or "Rice Creek." Untranslated wild rice names derived from Indian words for the grain or for its processing are omitted because these have as yet not been fully explored.

MILWAUKEE IN 1795.

This sketch of Mitchell Park, Milwaukee, Wisconsin, as it looked in 1795 was made by George L. Richards at the end of the nineteenth century from facts furnished by James S. Buck, who first viewed the scene in 1827. A good growth of wild rice may be seen on the Menominee River. The buildings are Jacques Vieau's trading post. (Sketch appears in J. S. Buck's *Pioneer History of Milwaukee,* Vol. 1, p. 55. [1890].)

strained at the oars, for here the growth of wild rice was remarkably thick—so thick that it covered the whole of the river channel.

The Menominees, the *Folles Avoines,* were the Indians with whom the French made their first Wisconsin contacts. The French term was also applied to the Chippewas of northern Wisconsin, within whose territories lay the Chippewa River, the Red Cedar, and the St. Croix, each of the three being known to the fur traders as the *Folle Avoine* because each furnished an abundance of wild rice.

This excellent native grain was relished not only by the Menominees and the Chippewas but was enjoyed by all the tribes inhabiting the great wild rice country. Many a bloody battle between Chippewa and Sioux was fought for the control of the wild rice fields of northwestern Wisconsin and eastern Minnesota, for the grain was very important to all the Indians of that area. The Sioux were finally driven out, but they returned year after year by stealth, or openly in force, to knock the rice kernels into their canoes and carry them to a safe place for further processing.

Lakes with extensive wild rice fields were what the Indians usually wanted when negotiating with the U. S. government for their reservations. Various petitions gave utterance to their great concern over the wild rice supply.

Because traders lived off the country they, too, were dependent on wild rice. The fur trade could hardly have flourished without it. During the harvesting season, and also at other times, if he needed it, the trader tried to purchase enough wild rice for his men as well as for himself.

Not once but many times, early travelers in Wisconsin and Minnesota mention wild rice as an important Indian food. The geographer Samuel Morse, in the first quarter of the nineteenth century, collected information on the grain at Green Bay and incorporated it in a report to the Secretary of War on the condition of the Indian tribes. Seemingly Morse's informants left the impression that the resource was inexhaustible, a point of view formerly all too common regarding many of our resources. Another geographer interested in wild rice was Timothy Flint. He noted that during the first half of the nineteenth century all the streams and marshes of the Northwest bore wild rice in abundance.

Besides travelers and geographers, government geologists sent out to study the mineral resources of the country usually had something to say about wild rice. Norwood, for instance, regarded one acre of wild rice as equal in nutritive value to one acre of wheat and considered it most unfortunate that the Indians of Minnesota left so much of it ungathered. Map makers took note of this important grain as early as 1688, when Franquelin lettered in the French equivalent of "wild rice lakes" along the Fox River, through which Father Marquette and Louis Joliet had passed fifteen years earlier on their way to the Mississippi.

As late as 1830 the phrase "full of W(ild) Rice" still appeared in the general area, this time on an American map. The eighteenth century is especially noteworthy for maps showing wild rice. "Passage into the country of the wild rice Indians," "Chippeway village called the Rice people," "Wild-rice village," and "Great Rice M(arsh)" are sample legends for Wisconsin and Minnesota localities.

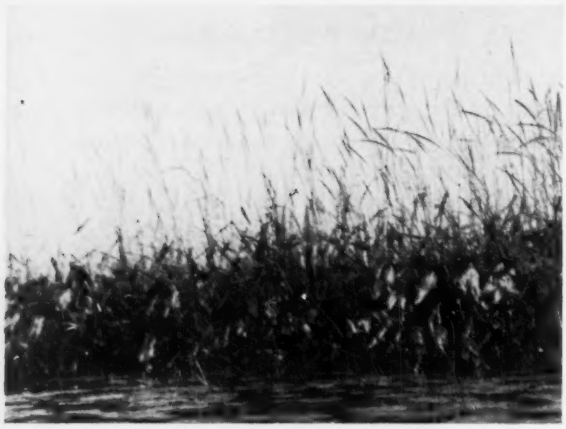
The Wild Rice Plant

Four languages were spoken at one time or another in the wild rice district and the neighboring territories—two Indian and two European. The Algonquian word for grain is *min*. To this the adjective *mano* "good" was generally added to make *manomin* ("good grain"). *Manomin* is the Algonquian, and *psin* is the Sioux, word for wild rice.

When the French first saw the plant, some, looking at the top of the head, noted a resemblance to rye, but others, observing the lower half, named it *folle avoine*. "Wild oats" made its way into the English language, but many other terms have also appeared, among them "Indian oats," "mad oats," "water oats," "Indian rice," "marsh rice," "Canadian rice," "squaw rice," "water rice," "wild rice." The plant is related to the rice so extensively cultivated in eastern Asia.

The ripe seed falls easily out of the husks as soon as it is developed, sinks down into the liquid mud

Wild rice field at Rice Lake, Burnett County, Wisconsin. Fierce battles were fought between Chippewa and Sioux Indians for control of the wild rice fields in northwestern Wisconsin. (Courtesy Milwaukee Public Museum.)



Wild rice field in the Fox River near Marquette, Green Lake County, Wisconsin. The Fox-Wisconsin River route was generally taken by explorers and fur traders in going from the Great Lakes region to the Mississippi River. (Courtesy Milwaukee Public Museum.)

at the shallow bottom of a marshy lake or river, and there lies until the following spring, to sprout and grow quickly to the surface early in June. A slender spike, four feet long, emerges from the middle of the stalk. The full length of the stalk is between two and ten feet, depending on the fertility of the mud and the depth of the water. The numerous leaves are long and broad. Growth is more vigorous in shallow than in deep water. Since young plants are easily damaged by floods, crop failures and famines were quite common. Wild rice fields have at various times been compared with fields of wheat, rye, barley, or oats, or with canebrake or Indian corn.

A tinge of yellow pervades the pale green of the fruit head, which is over a foot in length and located at the top of the spike. The yellow turns to a delicate purple as the head ripens. The lower portion of the head spreads out like oats, whereas the upper part, with its erect husks and awns, looks very much like barley. A slender kernel, half an inch or more in length, is enclosed within the husk. This seed is olive-green in color, cylindrical in shape, and smooth to the touch.

Wild rice occupied the marshy borders of sluggish streams or covered the whole area of shallow mud-bottomed lakes from Lake Winnipeg in Canada to southern Florida, and from just east of the Rocky Mountains to the Atlantic coast.

Harvesting. No care was needed or bestowed during the growth of the plant. The usual attitude was in general similar to that of the Menominees, who more than once expressed the opinion that their needs would be met by a kindly Providence, which would even cause wild rice to grow abundantly where formerly there had been none, just to supply the red men with their daily fare. Sowing as an insurance against want was not common, one reason being that the seed quickly loses its germinating power unless it is kept moist.

There was one operation to which the Indian women sometimes attended. When the kernels had reached almost their full size, the women prepared strands from the inner bark of the basswood tree. Going out among the tall stalks in canoes, they grasped an armful and loosely wound the bark strips around the stems until only the tops remained exposed. Next the tops were bent down in a loop and tied to the stalks. Since the tying was done in rows, a wild rice field took on the appearance of a grain field with its rows of shocks. The operation was designed to save the kernels from being eaten by birds or shelled out by strong gusts of wind.

In September the Indian women, two in each canoe, pushed their craft into the wild rice field with a slender twelve-foot forked pole, ordinary paddles being useless for propelling a canoe in the liquid mud. Grasping an armful of stalks, the woman at the front of the boat separated the heads from the spikes with a sharp blow of a stick, after having bent them over the side of the canoe. The kernels, husks and all, fell into a blanket or robe on the bottom of the canoe. Stalks were brought within reach by running a stick into them with the left hand. After filling the canoe, the women

Zizania aquatica L., var. *interior* Fassett, in Brokenhead River, two miles east of Beauséjour, Manitoba. (Courtesy W. G. Dore, Division of Botany, Science Service, Ottawa, Canada.)

pushed for shore, where the processing was completed.

Each family gathered according to its desires, sometimes five bushels and sometimes as much as twenty-five, but the latter amount was rare. Again and again white observers noticed that the Indians showed little foresight in laying in their stores. Although abundant supplies were at hand in those early days, many Indians shunned the necessary labor connected with getting the grain ready for storage. Other travelers, however, have told of obtaining wild rice in quantity as late as July, several weeks before the new harvest, this rice having been kept over from the preceding year.

For easy removal of the hull, the kernels had to be dried, which was done by either of two methods. The simpler one was to spread the kernels on a robe and let them dry for a day, preferably under a bright sun. The Indians also resorted to slow heat and smoke. After making a scaffold of poles three feet high and covering it with cedar slabs, they spread the kernels on top, then built a fire underneath, which they fed until the grain was completely dry, perhaps for a day, or even longer.

A third technique preparatory to hulling was parching. An iron kettle filled with wild rice was put over a slow fire. The contents were stirred continuously to keep the rice from burning. The parching process involved extra work, but turned out a superior product.

The simplest way of taking off the hull was to rub the kernels between the fingers. Larger quantities, naturally, demanded other methods. Sometimes the kernels were put into baskets or blankets and vigorously shaken. Also effective was pounding with a stick in a bag, or in a circular or oblong hole lined with deerskin.

Treading with the feet was the most common method of loosening the hulls. About a gallon of wild rice was put into a hole, then a man hopped around on it with his moccasins. He balanced himself by means of three long poles set up like a tripod, or grasped the branches or trunk of a tree. The term "jigging" or "dancing" has been applied to this part of the process, because the removal of the hulls demanded a twisting motion of the feet. Holes where hulling was carried on have been reported for Lake Koshkonong, Fox Lake, and Rice Lake (Barron County) in Wisconsin.

Separating the hulls from the grain was done with the aid of the wind. Tossed up into the air, the kernels fell back into a birchbark tray and the

Treading (jigging) wild rice at Lake Itasca, Minnesota. (© National Geographic Society.)

lighter chaff was blown away. Later the more enterprising gatherers used birchbark fans patterned after those in use on the farms of the white settlers.

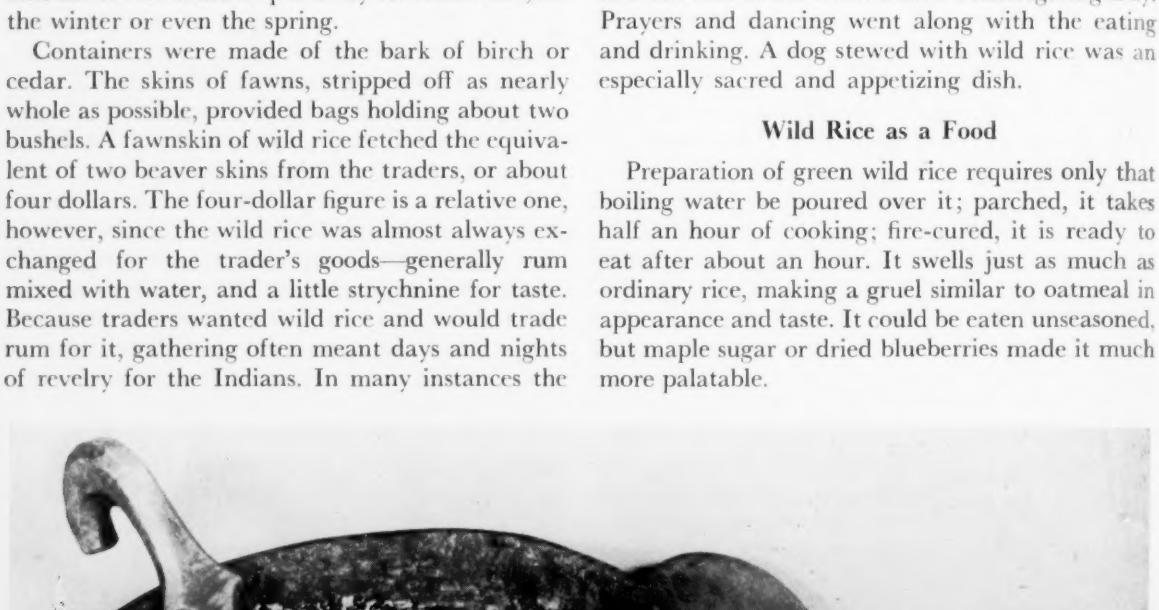
Pits in the ground served as storage places. The amount stored depended on circumstances and the intentions or energy of the gatherers. Because game was plentiful at this season, a considerable amount of rice could be put away for future use, for the winter or even the spring.

Containers were made of the bark of birch or cedar. The skins of fawns, stripped off as nearly whole as possible, provided bags holding about two bushels. A fawnskin of wild rice fetched the equivalent of two beaver skins from the traders, or about four dollars. The four-dollar figure is a relative one, however, since the wild rice was almost always exchanged for the trader's goods—generally rum mixed with water, and a little strychnine for taste. Because traders wanted wild rice and would trade rum for it, gathering often meant days and nights of revelry for the Indians. In many instances the gatherers became so interested in their festivities that they neglected the harvest, to the great displeasure of the Indian agents, whose reports to Washington contained frequent complaints of too much feasting and not enough harvesting.

The wild rice feast came before, during, or after the harvest—exactly when was not important. Religious ceremonies accompanied the social pastimes, as is the case in the white man's Thanksgiving Day. Prayers and dancing went along with the eating and drinking. A dog stewed with wild rice was an especially sacred and appetizing dish.

Wild Rice as a Food

Preparation of green wild rice requires only that boiling water be poured over it; parched, it takes half an hour of cooking; fire-cured, it is ready to eat after about an hour. It swells just as much as ordinary rice, making a gruel similar to oatmeal in appearance and taste. It could be eaten unseasoned, but maple sugar or dried blueberries made it much more palatable.



Wild rice bowl and spoons. Grains outside the bowl have not been hulled. Wild rice was cooked like oatmeal and eaten with spoons. (Courtesy Wisconsin Historical Museum.)

Grease from bear or buffalo was a common seasoning. Venison, fish, or fowl added to the wild rice boiled up into a splendid stew. A mixture of wild rice, corn, and fish was also greatly favored. The wild rice entered these dishes either pounded or unpounded.

Producing both heat and fat, wild rice, supplemented with meat, gave the Indians a diet upon which life could be sustained. Unfortunately it did not last throughout the whole year; sometimes there was enough for the autumn and winter months, and once in a long while a little left over for spring.

Wild Rice Today

Because it has been destructively harvested for decades by birds and man, wild rice has carried on a losing fight for survival. Artificial sowing of the grain as feed for wild ducks has been only moderately successful. The large fields are yielding much less abundantly or not at all. Harvesting while the kernels were green was a speedy way of reducing future yields, for green grains shaken loose during the gathering have a much lower germinating capacity than ripe grains, thus making the stands thinner and thinner from year to year. Only in isolated spots does wild rice continue to be harvested by the same methods, though not in the same quantities, by Indian gatherers, not as a staple food for themselves but for special feasts or for sale. Minnesota has one or two small collection depots managed by white men who process and package the wild rice brought in by the Indians. In eastern Manitoba, there is a wild rice "farm" where the grain is grown for the Canadian and United States markets. Fashionable restaurants occasionally serve wild rice as a novelty dressing with turkey or pheasant.

The once-extensive fields that led men to think this wild grain inexhaustible show only faint signs of their former productivity. But the names suggestive of the plant or the gathering of its seeds have remained. Wisconsin has about twenty water features, lakes, rivers, or creeks, bearing the name "Rice," and Minnesota has around ninety. *Manomin*, too, continues to tell the story of wild rice, as for instance the two Menominee rivers of Wisconsin or the three Manomin lakes of Minnesota; and numerous untranslated native names of lakes and rivers are the words used by the Indians for places where the kernels were beaten off the plant with sticks.

Wild rice grown on a "farm" near Pointe du Bois, in eastern Manitoba. Operations are on a commercial scale, the wild rice being sown, harvested, and processed by machinery. (Courtesy Ducks Unlimited, Canada.)

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The Political Ecology of Alaska*

ERNEST GRUENING

Ernest Gruening has enough careers to his credit to satisfy half a dozen ordinary men. He never made direct use of the M.D. he earned at Harvard in 1912, for he early developed an interest in newspaper work. Following this career, in the course of which he founded the Portland (Me.) Evening News *and served as general manager of* La Prensa, *he entered the Department of the Interior, functioning for a time as administrator of the Puerto Rico Reconstruction Administration. His record as Governor of Alaska is well known, and this article reveals the secret of his successful career there, for he seems more Alaskan than the Alaskans.*

A SCIENCE conference such as this suggests discussion in the field of the natural sciences such as ichthyology and zoology, with their practical relationship to the fisheries and wildlife and to the preservation and augmentation of their valuable food, fur, and recreational resources. It connotes geology and mineralogy, with their close relation to mining. It connotes soil chemistry, botany, and entomology for their vital bearing on the most basic of all economic pursuits—agriculture. It connotes meteorology for its relation not merely to agriculture but for its more recent and even greater importance to aerial navigation. It connotes paleontology, archaeology and anthropology for their prehistoric and historic background of the people. It connotes ethnology for the approach to their past and present habits; the medical sciences for the essential problems of their current and future health.

But the social sciences, those presumably and actually less exact disciplines, under whose inclusive mantle ethnology merges into sociology, economics points up the practical objectives of the natural sciences, and political science deals with the theory and practice of government—all these would perhaps have been deemed little related and nonpertinent here. Yet they do, I feel, deserve an equal place in such a science conference. For, as we have in recent years become increasingly aware of the interrelation and inseparability of all scientific disciplines, as we have grown increasingly alert to the fusion of so-called pure research and of applied science, so should we, today, as never before, become conscious of the broadening base and pertinence of political science.

First, let us note the obvious fact that all science can flourish only in a climate of political freedom. That fact has been ruthlessly driven home, for example, by the discovery that in the free world we have a science of genetics, but in the world of the Iron Curtain something that may be designated Soviet genetics. That something will henceforth be associated with the name of Lysenko, signifying intellectual betrayal. We are therefore met here, whether as chemists, physicists, biologists, or political scientists, more acutely aware than ever, since the passing, a few centuries ago, of medieval obscurantism and the emergence of Baconian experimentation, that our political purpose, our economic condition, and our social habits—in short, our way of life—are indispensable to the erection of any and all edifices where truth may dwell unterrified and unfettered. And it is pertinent that we meet here in what was once Russian American, in an area juxtaposed to and historically and geographically related to a realm where such a conference would today be impossible. Although many scientists in the government service are represented here, no censor, no spy, no undercover agent, no police official, is among us.

The governmental structure by which this freedom has been nurtured, the economy that has flourished under it, the social habits that the people have concomitantly developed—these, so far as Alaska is concerned, will be the subject of my address. An explanation of my title is scarcely necessary. I purpose to discuss the relation of the human organisms that have constituted and still constitute Alaska's population to their institutions, public and private, and to their physical surroundings. Polit-

* Based on a speech delivered by Governor Gruening at the second Alaskan Science Conference, held last September at Mount McKinley National Park.

ical ecology would be far, far from an exact science. But how many sciences, since the advent of relativity and the discovery of the transmutability of the elements, can any longer be considered exact? The political ecology of Alaska is a combination of many ingredients. It is, first of all, history, in the broad sense that everything that is past is history. It is political history, economic history, social history, all closely interwoven. It is contemporary history of the same varieties. It may include some elements of prophecy analogous—but with far more uncertainties and variables—to the forecasting of weather or the putting of the probables and possibles of demographic curves, or the planning of a budget.

Geography, climate, terrain, ethnic factors, all bear importantly on what Alaska has been, is, and may become. The ethnic, or human, factor, if I may utter an arbitrary judgment, is the most important of these. For what man has done, does, and may do with natural conditions and resources determines the future of his society. The primitive savage dwells eternally among untold bounties of nature, knows them not, and puts them to no beneficial use. The informed modern troglodyte may know of them, yet pervert and misuse them. Consider, for instance, the scientific miracle of radio—broadcasting the voice of the late Paul Joseph Goebbels! Consider on a different plane the reckless misuse and wastage of natural bounties by early exploiters. Consider, in short, that the flowering or destruction of man's hopes rests largely on his proper utilization of knowledge. That wise application of the mounting heritage of knowledge, should, broadly speaking, be the underlying purpose of society. That may be said to be the function of applied political science. Its recording we shall denominate political ecology.

Early Economic History of Alaska

Our forefathers on this continent set a high aim and a perpetual objective when they enshrined in our Declaration of Independence the immortal words "life, liberty and the pursuit of happiness." How pregnant with new meaning is that declaration today! But how nearly have we approached and attained that trinity of objectives? The history of the United States could be written in terms of an answer to that question. Let us try to answer it for Alaska. How have we done in Alaska?

Let me say first that the historical process in Alaska is pretty well encapsulated and telescoped. Of the motives that brought the prehistoric migrants to Alaska, presumably from Asia, we know very little. What caused the ethnic diversification into Aleut, Eskimo, Athabascan, Thlingit, is still in the realm of theory. Within recorded times, however, we find the economic basis of history, stressed by some of our early twentieth-century historians, strongly in evidence in Alaska.

It was the quest for furs that largely motivated the Russians' eastward expansion across Siberia in the seventeenth century, to the shores of Bering Sea and across it into Alaska in the eighteenth century. The sea otter and the fur seal principally determined the early history of Alaska. The fur trade was likewise a potent incentive to the purchase of Alaska by the United States. Interested Californians promoted it and were rewarded by having Alaska's fur-seal traffic handed to a San Francisco company as a monopoly. It was the misuse of that natural bounty that also wrote Alaska history. The ruthless killing of sea otter and fur seal by the Russians led to the minimization of Alaska's value in the eyes of the Russians and, among other motives, led to its sale to the United States.

It was the further misuse of that natural bounty by succeeding American exploiters that led to intensive regulation, to government operation, to international agreement, and to the enactment of wise conservation policies regarding pelagic sealing. The rebuilding of the dwindling fur-seal herds and the re-establishment, still in process, of the virtually extinct sea otter, are triumphs of conservation and of government. Conservation measures similar to those adopted for the fur seal and sea otter, though on a more limited basis, led to the regulation of the salmon and halibut fisheries.

Although it may be ventured that without such regulation the salmon fisheries would long since have been destroyed, it is too early to classify this episode in regulation as wholly successful. Here is an interesting example, among many, in which the success of an undertaking depends on the attitudes of a changing body of congressmen whose interest and knowledge are often limited and transitory. The present fisheries conservation program, concerning which I can give my opinion advisedly, is now more ably administered than at any previous time, but still suffers greatly from lack of funds. It is in large degree a policing program to apprehend and restrain violations which unchecked will diminish the supply of salmon. Congress has never provided adequate safeguards for this invaluable resource, yet insists on leaving control in federal hands. It is for this reason that for years the Territory, through its legislature, has sought the transfer of fisheries. It is for this reason it created three years ago a Territorial Department of Fisheries. The function of the territorial agency

is to cooperate with the federal, to supplement it, and to help the federal government do the job it ought, through no fault of the agency itself, to be doing better.

Wasteful practices in the destruction of U. S. forests led to corresponding conservation policies and the setting aside of national forest reserves, among which Alaskan forest areas were included.

Changing times and conditions have not always inspired appropriate adaptations by government agencies, which were initiated to meet existing needs but have become permanent institutions in Alaska, sometimes for good, sometimes for ill. At one extreme we have the wholly successful preservation of the pelagic fur bearers. At the other, Alaska has suffered through the years from the unnecessarily restrictive and often ill-advised policies of regulatory agencies. The acts of unseen men in distant bureaus, or in congressional committees, profoundly affected our lives—often adversely. And long-range government in Alaska has not on the whole written a glorious chapter in American history.

Let me summarize. Not that I desire to go over old ground, but because understanding of the past is indispensable to an understanding of the present and for a projection of the future.

The political ecology of Alaska as part of the United States began with the purchase in 1867 of what had been called Russian America. The purchase price of $7,200,000, or less than 2 cents an acre, represents a bargain that may some day be considered comparable to, or even to surpass, the purchase of Manhattan Island for $24. In the past fiscal year Alaska has returned to the federal treasury in income taxes alone over five times the original purchase price. Secretary Seward's statesmanlike view embraced the purpose of extending the American idea as far as possible over all the North American continent. The purchase, in fact, represented extension northwestward of the Monroe Doctrine. Nevertheless, Seward did not escape the abuse and mockery that is inevitably heaped on men of vision and action who are ahead of their time. It was in the debates concerning the purchase of Alaska and the payment thereof, and in contemporary newspaper comment, that such disparaging epithets as "Seward's Folly," "Icebergia," and "Walrussia" were fastened upon the Territory. Then and there Alaska achieved the misrepute of being a land of snow and ice, an arctic waste unfit for habitation, a misconception that has, to a very considerable measure, persisted to this day.

Having achieved the purchase, federal authorities, legislative and executive, forgot Alaska. They established no government. In the first seventeen years only two laws wholly applicable to Alaska were passed by the Congress. One created an Alaska Customs District and put a collector of customs in charge, which meant only that foreign goods entering Alaska would pay the same duties as elsewhere in the United States. The other turned over the Pribilof seal fisheries as a monopoly to a private San Francisco company, a transaction which, as pointed out before, in considerable degree motivated the purchase. For seventeen years it was not possible in Alaska to marry legally, to deed or transfer property, to punish crime. Four presidential administrations, plus one year, constitute a startlingly long period of absolute neglect. One might assume that, having acquired this vast territory, our lawmakers or federal executives would have displayed some interest leading to a study and program to ascertain the resources and proper treatment of this vast acquisition. There was no such concern. America was too much preoccupied with the mammoth task of conquering the West, spanning the continent with railroads, settling the prairie, mountain, and Pacific Coast states and territories. It may therefore be said that the congressional lawmakers merely reflected the almost total unawareness and lack of interest of the American people in Alaska.

Such rule as existed in Alaska in the absence of any legally constituted authority was exercised by the commanding general of the small Army contingent stationed at Sitka. When he and his men were recalled to the States to help put down an uprising of the Nez Percé Indians in Idaho, there was not even that semblance of government left in Alaska. When a few white settlers became alarmed that there might be a similar uprising, a fear which, incidentally, was widespread throughout the West in the 1870s, the inhabitants of Sitka asked that a war vessel be stationed in Alaskan waters to safeguard them in event of trouble. Washington paid no heed. The requests became more insistent. They were ignored. Finally the Alaskans appealed to their neighbors, the Canadians; in consequence a British man-o'-war came to Alaska and His Majesty's ship performed service that should have been performed by the United States Navy. When, some months later, an American war vessel arrived, its captain became for the next two years the *de facto* ruler of Alaska. Without any legal sanction, Alaska was variously ruled during those years by officials of the War, Treasury, and Navy Departments.

In 1884 Congress decided that perhaps it was time to do something about Alaska and, without

too much knowledge or consideration, adopted the first organic act. It provided a governor, a district judge, a United States marshal, and four lesser judges who were to serve without salary and to subsist on the fees they could collect from the public. A sum of $25,000 was appropriated for education, which up to that time had been carried on wholly as a private and voluntary enterprise by missionaries. The code of the state of Oregon was applied to Alaska. It had been good for Oregon, so why not for Alaska? Unfortunately, the Oregon code prescribed many functions for county officials, but there were no counties in Alaska. The Oregon code likewise provided that in order to be a member of a jury one had to be a taxpayer. But as Congress had not provided for taxes to be levied in Alaska there could be no trial by jury. In other words, the administration of justice according to constitutional principle was still not possible.

The newly created executive, the governor, had little law under which to operate and virtually no means had he had the law. For the next fourteen years a succession of governors tried, with slight effect, to interest Congress in passing suitable legislation for Alaska.

Not until the Klondike gold strike, in the late nineties, was Alaska temporarily rediscovered by the American people. Only with the rush of prospectors to Alaska, and their realization that they had little or no law with which to assure their claims, and that much else was lacking, did their caustic protests to senators and congressmen bring the beginning of legislation. Some of this was fair, some inappropriate, some unworkable, as might be expected in those days of slow communication from legislators thousands of miles from an area of which they knew little or nothing. And so there arose a cry for someone who could officially represent Alaska and speak for its people and their needs, and a demand for some effective form of self-government. It was not until 1906, however, that the Congress authorized a delegate, and not until 1912 that Congress replaced the unworkable act of 1884 with a new act creating a territorial government with a legislature.

The organic act of 1912, although a vast improvement on its unworkable predecessor, was notable chiefly for the restrictions on self-government it placed on Alaskans. The legislators were not permitted to make any basic land laws, a glaring omission which has thwarted and continues to thwart the settlement and growth of Alaska to this day. They were allowed no voice in the regulation of their principal natural resource, the fisheries, and of their wildlife. Both functions were retained by the federal government. They were not allowed to incur any indebtedness or to bond themselves for any purpose whatever without previous consent of Congress. They were not allowed to have their own judiciary, unlike the Territory of Hawaii.

When the first Legislature assembled in 1913 it made an excellent start in fields within which it was permitted to function. Its first act was to enfranchise women, thus preceding federal action on equal suffrage by seven years. When it found, however, that there were substantial fields in which it was not permitted to operate it memorialized Congress on half a dozen basic issues.

It requested that Congress liberalize the land laws and thus encourage and promote settlement. Closely related to this, it memorialized Congress to put an end to reservations and withdrawals and to rescind some already made, to make settlement possible. It asked that United States commissioners, the lower court judges, be paid a salary. It requested Congress to make provision for roads, and to take appropriate action to stimulate agriculture. It requested that maritime transportation rates, which the legislators in that early day deemed excessive, be reduced.

Up to four years ago, thirty-four years later, not one of these requests had been complied with in any form whatever. Today a beginning has been made in three out of the six. I think it is difficult to overstress the importance of that fact. For some thirty-four years these requests, all reasonable, hardly any of them controversial, were completely ignored by the Congress. Alaska had been placed in a legislative strait jacket. Through its limited local authority it sought to set up government functions as well as it could. But in vast and important fields in which Congress alone could operate, Congress steadily ignored its responsibility and Alaska's needs. One would have assumed that having conferred extremely limited powers of self-government upon the people of Alaska Congress would gradually enlarge those functions. But no such thing happened.

Consider the requests separately!

The federal land laws drawn up nearly a century ago for the states are inappropriate and unworkable for Alaska. With 586,000 square miles of sparsely settled territory, of which over 99 per cent is federally owned, it has been impossible to purchase outright from this vast holding a small tract for a home. For decades pioneers hopefully attempted to meet the requirements of homesteading. With great effort and endurance they cleared the forest and hewed a home from the wilderness, only to find themselves defeated by the red tape of un-

workable and maladministered regulations, and, unable to secure title, pulled up stakes and got out.

In the extensive National Forest areas, the Tongass, which coincides approximately with all of southeastern Alaska, and the Chugach, which includes the principal coastal area of central Alaska, it has been impossible to purchase outright from the controlling federal agency a half-acre tract for a home, or a five-acre tract for a tourist lodge. A permit renewable from year to year for use and occupancy under certain restrictions, or the cumbersome process of homesteading with a view to ultimate patent, a process encumbered by obsolete procedures and the frustration of dealing with two federal agencies, has been the only approach. A slight liberalization in the laws has, after desperate effort, been secured in the past two years. Further liberalization is in prospect. Procedures of the Bureau of Land Management have likewise improved enormously in that period. But here good intent is again frustrated by the cumulative legacy of the past, coupled with totally inadequate funds for surveys. Further revision of law and procedures is still needed to promote rather than obstruct settlement.

The collateral request of the first legislature that Congress cease making reservations and withdrawals was not merely ignored; instead the process was accelerated. Alaska today is a crazy quilt of reservations and withdrawals by every federal agency, and for a variety of purposes. There are the National Forests, the vast military reservations, naval oil reserves, Indian reservations, wildlife refuges, and withdrawals for settlement projects and for miscellaneous purposes. Some were made so long ago that their original purpose has long since been abandoned. Seldom has restoration been made when the need ceased to exist. The withdrawals often overlap and conflict. No one, literally, knows how much and what has been withdrawn, and why. Some months ago the Department of the Interior finally set for itself the task of analyzing, recording, and mapping in visible form the multitude of areas withheld from free public or private use for one purpose or another. But to this day the making of withdrawals and reservations, against which the first territorial legislators inveighed thirty-eight years ago, has proceeded without let or hindrance.

It was in 1884 that the first Organic Act, in establishing Alaska's judiciary, provided that the then four federal lower court judges, or United States commissioners, should be unsalaried. Sixty-seven years have passed. The number of commissioners now approximates sixty, and they are still dependent for a livelihood on the fees they can collect from the public. Except in our principal cities—Ketchikan, Juneau, Anchorage and Fairbanks—these revenues are insufficient to keep body and soul together. It is not possible, therefore, for the district judge, who appoints them, to find qualified and worthy commissioners in all cases. The administration of justice suffers, and yet Congress refuses either to let go or to do its job.

Law enforcement outside of municipalities has since 1884 likewise been kept as a federal responsibility, being entrusted to the United States marshals and their deputies. Their authority is inadequate; it appears to be limited principally to process serving. Their numbers are inadequate, especially to meet the impact of thousands of defense workers and the inevitable camp followers of a boom. It is in the areas just outside the cities, where the municipal police have no jurisdiction, that the no man's land of lawlessness lies. The federal government has not done its duty in these areas. President Truman has recently forcefully demanded improvement, but here again Alaska's law enforcement depends on action by a Congress always far in arrears in its schedule.

Six years ago, however, the Territory began the organization of a highway patrol, which will develop into a territorial police. For the time being it is rendering excellent service patrolling the rapidly increasing traffic on the new highways. The request of the 1913 territorial Legislature for road construction, unheeded for thirty years, received some attention incident to military necessity. Congress has never seen fit to include Alaska in the federal highway program (except to a limited degree in the National Forest areas) and, except for the Richardson and its extensions, Alaska had virtually no highways.

The Indifference of Congress

Then in the wake of Pearl Harbor the Alaska Highway was hastily constructed; the Glenn Highway linked Anchorage with the Richardson; and the Tok and Haines Cutoffs provided further mileage. But not until three years ago was a real program of road construction initiated under the Alaska Road Commission. Seward and the Kenai Peninsula in the south are now linked in the network. In the northeast the Forty-Mile area, long important in mining, is connected. A road from the Richardson Highway to McKinley Park is under construction, and a road connecting Cordova with the rest of the system is, we hope, imminent. But only military requirements, let us admit frankly,

brought that program into being. Under the *Federal Highway Act,* passed twenty-eight years ago, Alaska's share has been estimated for the period at some $300,000,000. Some matching funds from the Territory would have been required. But the Congress was never willing, in the days before the international situation threatened, to consider any road formula for Alaska. The states just did not wish to share with the Territory from the common fund.

The 1913 Legislature expressed a desire for the promotion of agriculture. But after Alaska's land-grant college was established ten years later, Congress repeatedly withheld funds authorized and due the Territory for agricultural research and extension work. It should have been clear that agriculture in Alaska could profit only to a limited degree from experience in the States, and that Alaska's climates, untried soils, and unknown entomology required special study. After long years of effort, a change of policy, possibly stimulated by reports of successful agronomy in far northern Siberian latitudes, was effected four years ago, and existing research much amplified. But now it is again threatened by withdrawal of funds by Congressional enactment.

Finally came the request of the 1913 Legislature that transportation rates be reduced. The story of the regulatory agencies that formulate our merchant marine procedures is too long to be told here. There has been little difference visible to Alaskans between the United States Shipping Board, its successor, the United States Maritime Commission, and its most recent sequel, the United States Maritime Board. But the request for reduced freight rates has been repeatedly re-echoed by subsequent legislatures.

I think it may be stated that this inaction on the part of Congress bears an unescapable relation to the lack of growth in Alaska during a period when every other part of the United States was making advances. During the years from 1900 to 1930 the population of Alaska actually diminished. The census of 1900 gives a population of 63,592, but the census of 1930 gives a population of 59,278. During those same three decades the population of the United States increased by 45,000,000. Federal policies beyond the control of Alaskans were strangling Alaska. These over-all and determining policies had their effect on the Alaskan's own limited field of legislation. Where there was no growth and, in fact, an actual shrinkage, while everywhere else under the flag there was progress, it was understandable that an attitude of defeatism, timidity, and caution should dominate the thinking of Alaskans concerning Alaska.

This attitude may likewise be traced directly to Alaska's economic origins. The Pacific salmon fisheries attracted some investment in the closing decades of the nineteenth century, but its activities were haphazard, unregulated, and entirely seasonal, its employment was migratory and led to no settlement in the Territory. The discovery of gold at Nome, in the Yukon basin, and elsewhere in Alaska, following the first Klondike strike in 1897, brought thousands of prospectors into Alaska. But their objectives, not unnaturally, were to get gold and to return to the States with their profits. They came not as prospective settlers desiring to found a home—not as the preponderance of immigrants from the beginnings of American history, who had successively crossed the Atlantic, the Alleghenies, the Plains, and the Rockies, in search of a freer environment, greater economic opportunities, and permanent abode. Unlike the earlier waves of Americans, the Alaskan pioneers came rather in the spirit of conquistadors in quest of gold, with the purpose of returning to the motherland to enjoy their newfound wealth. Like the Spanish conquistadors, few of the goldseekers brought their women. Thus the early period of Alaskan immigration differed sharply from the corresponding period elsewhere in the United States. That difference, though important, was not surprising. Alaska, except for the lure of gold, had little or nothing to offer women. It was a wilderness without roads, schools, or any of the accoutrements of modern civilization, or the prospect of attaining them. And so Alaska, during the first three decades after the gold discoveries at the turn of the century, remained, except for the aboriginal population, largely a domain of transients. Their psychology, naturally, made for continued impermanence. Where there was no intention to stay, there was no incentive to improve the environment. Temporary shelter, log cabin or shack, would do. Why put a hook in the wall where a nail should suffice?

Some, of course, remained, though unsuccessful in their quest for gold, but with the gold miner's eternal optimism for the coming season. But seldom, until habit or old age overtook them, did they relinquish their intent to leave Alaska as soon as their hoped-for fortune was acquired. The same psychology afflicted the traders. This thinking in turn enabled federal and territorial authorities to rationalize their inaction. Nevertheless, some slight progress toward permanence was visible here and there. The government built a single-

track railroad from the coast to the interior, which was completed in extremely rough fashion in the early twenties. A land-grant college was likewise established near its northern terminus as an agricultural college and school of mines, which later became the University of Alaska.

A concomitant effect of long-range federal control may be seen in the efforts of Alaskan legislatures to increase as far as they possibly could the territorial autonomy. New offices and new boards were created through the years. The offices of attorney general, auditor, treasurer, commissioner of education, and highway engineer were created, all of them elective, although the commissionership of education was later made appointive by a board. It is fully understandable that with the executive power vested in a federal appointee, frequently nonresident at the time of his appointment, the people of Alaska should strive for an increasing voice in their government. Contemporary thinking concerning the structure of government has veered away from elective officials to appointive. But as long as the appointing power is vested in a federally appointed executive it is inevitable that the people should desire to retain, and will retain, as many electoral powers as possible. In sum it may be said that during the first two thirds of a century of Alaska's rule by the United States no constructive policy whatsoever for Alaska was evolved. Alaska was ruled by distant federal bureaus, and its needs were scarcely apprehended by the occasional visiting committee of congressmen, who came, enjoyed themselves, and returned home, seldom with sequent action. It was not until the middle nineteen thirties that a new interest in Alaska began in Washington. That interest was accelerated by international events.

Interest in Alaska

Although in the twenties the late General William Mitchell, prophet and pioneer of military air power, had forceably called attention to the great strategic importance of Alaska, and the need for defending it, his wisdom in this respect, as in the domain of military aviation, had been totally disregarded. As late as the close of 1939, two years before Pearl Harbor, the only military or naval establishment in Alaska was an obsolete infantry post at the upper end of the Inside Passage, dating from the gold-rush days. It was manned by 200 infantrymen, equipped with Springfield rifles, and without either a machine gun or an antiaircraft gun. Even that miniscule detachment, which represented the totality of the armed might of the United States in Alaska, was less effective than even its infinitesimal numbers would imply. Chilkoot Barracks, near Haines, was at that time unconnected by any road to the interior. The mobilization of this 200-man detachment depended upon a harbor tug, more than half a century old, whose engines were so feeble that at one time its commanding officer and staff, returning to Chilkoot Barracks from Juneau, and encountering a head wind blowing 25 miles an hour, were unable to make headway and had to be rescued by the Coast Guard! Despite some belated preparations immediately preceding the outbreak of World War II, Alaska was virtually defenseless and in consequence was the only part of America that was invaded and for a time occupied by the enemy. Yet for years Alaska's voteless delegate in Congress had pleaded unceasingly for Alaskan defenses. Indeed, he had prophesied what would happen. But Congress paid no heed. Alaska's delegate pointed out that ever since 1904 the island of Kiska with an excellent harbor, at the outer end of the Aleutian chain, had been set aside as a reservation for the U. S. Navy. But the navy that first occupied Kiska was not that of Uncle Sam but of Emperor Hirohito. Although it is true that the Japanese enemy, shattered at the Battle of Midway, was driven out of Alaska a year later and defeated there as everywhere else, the entire Aleutian campaign, with its heavy involvement of ships, materiel, and men and, more serious, with its substantial loss of American lives, was unnecessary. It could have been avoided by proper Alaska defenses. Experience indicates that in the intervals between wars, in the piping times of peace, national defense has a tendency to follow the pork barrel. It was so in Alaska. A voteless delegate, be he ever so able and indefatigible, as most of Alaska's delegates have been, carries little weight in a conflict of interest as against senators and voting members of the House of Representatives.

World War II, however, despite its tragic aspects, proved a great boon to Alaska. The role of war as the great destroyer is familiar to everyone. But less has been said of the constructive aspects of war. Needed physical improvements, the acceleration of vital research, important inventions, the development of new surgical techniques and medical remedies, are all speeded by war—a sad commentary, no doubt, on our "civilization."

Prior to World War II, and the preparation therefor, Alaska had no air fields, it had no radio range stations. Yet Alaska was the most air-conscious part of America. Alaskans, on the eve of

World War II, were flying more than thirty or forty times as much as other Americans. Bush pilots, pioneering the airways of their vast roadless terrain, brought about speedier access to all parts of Alaska. Their fields were the beaches, sand bars, rivers, lakes, the snow-covered tundra in the northern parts in winter, and even the pack ice in the Bering Sea. Unaided, and by their own energy, courage, and skill, these bush flyers developed a fine system of intra-Alaskan aviation. Yet communication between Alaska and the United States, depending on economic factors outside the control of Alaskans, and on the approval of distant bureaus, lagged far behind. Alaska was connected commercially with the United States by air for the first time in 1940, long after such service had been established between the United States and South America and Asia. Air transportation was admirably suited to Alaska, because of its lack of other forms of transportation. Defense and aviation gave a new drive to the development of Alaska.

An increasing interest in Alaska became manifest in Washington during the middle thirties. The Matanuska Colony gave Alaska nation-wide attention as a new frontier, gave agriculture in Alaska a new impetus. Social security, federal housing, the CCC, came to Alaska as part of a national program. But obsolete, long-range government controls still greatly retarded development.

Alaska, through the years, had become increasingly the province of one of the important departments of the federal government, the Department of the Interior. Not only were the territories—Alaska and Hawaii—and the insular possessions, placed under its supervision in 1934, but the majority of important federal activities in Alaska had been or were transferred to it. They include such important agencies as the General Land Office (now rechristened the Bureau of Land Management), with jurisdiction over most of a land area one fifth as large as the United States; the Fish and Wildlife Service, which has the important assignment of regulating and conserving the fisheries and wildlife; the Office of Indian Affairs, which had until recently complete control and supervision of the education, health, and welfare of the "native" population, the Indians and Eskimos, who twenty years ago constituted one half the total population; the Bureau of Mines and the Geological Survey, with their important relation to what has long been Alaska's second industry, mining; the National Park Service, which for a quarter of a century has had jurisdiction of three vast areas, of which only one, Mount McKinley National Park, has had a single cent spent on its development; and, finally, the Alaska Railroad and the Alaska Road Commission, to which has been recently added the Alaska Public Works. Thus enormous power was and is vested in a single federal official, the Secretary of the Interior. His character and his ideas have in past years largely determined the fate of Alaska and can shape it for the future. If he is a believer in what was once designated by a nationally known columnist as the "papa-knows-best" theory of domination, if he is indifferent to the wishes of large segments of the Alaska population, if his rule is autocratic and curmudgeonly, Alaska suffers, and indeed has suffered.

Such domination and its far-reaching consequences may be illustrated by brief reference to the department's Indian policies. Two generations ago the federal government established for the so-called native population—the Eskimos of the Bering Sea and arctic coasts and of the river valleys, for the Aleuts along the Peninsula and in the Aleutian Islands, for the Athabascan Indians of the interior, and for the Thlingits, Haidas, and Tsimpsians of southeastern Alaska—a policy of separate education and supervision by the Office of Indian Affairs. At the time of its origin it was undoubtedly an appropriate policy in view of the relatively primitive status of most Alaskan "natives." It undoubtedly coincided also with the attitudes of white Alaskans, who felt that this was certainly a federal responsibility. It corresponded with the Territory's financial limitations. Likewise, there existed on the part of many white Alaskans a prejudice against the aboriginal brethren not dissimilar from that existing in many parts of the United States, and the separate establishment satisfied that sentiment where it existed.

The New Alaska

Evolutionary improvement, however, and action by the Alaskans themselves brought about a change. An antidiscrimination bill, which put an end to the occasional practice of excluding Alaskans of "native" stock from inns and other public establishments, was passed by the territorial Legislature of 1945. Voting precincts were established in numerous Eskimo communities where there had been none. Men of "native" blood became more acutely interested in the Territory's affairs and were elected to the Legislature. Their numbers have increased, and they have served with ability. In the 1951 Legislature, out of 40 senators and representatives, 4 were of Eskimo and 2 of Indian blood. "Natives" have likewise

received recognition by appointment to various territorial boards.

Paradoxically, at almost the same time, a new policy, promulgated in Washington and imposed on the people of Alaska without consultation or consent, initiated the establishment of vast reservations on which the "native" people were to be segregated. It would have created two classes of citizens and, under the guise of benevolence, permanently assigned a vital and important portion of our population to a Jim Crow status. After a change in the secretariat, the policy seems to have come to a halt and is in the process of being reversed, following greater consideration of the wishes of Alaskans both "native" and white, and a saner understanding of the American principles of equality and freedom. But the consequences of this arbitrarily imposed, reactionary policy with its by-products of friction and confusion will, unfortunately, affect Alaska adversely for some time to come.

Let it be noted here that the Eskimo and Indian population of Alaska has, broadly speaking, been until recent decades the only certainly permanent part of the Alaskan population. Eskimos and Indians were here first, and presumably they will always be here. They are year-round residents. They are not in the category of those (until recently a substantial portion of the population) who came to Alaska to make a stake and leave. In terms of an artificial standard of measurement, "man-months of residence," the "natives" constitute a proportion of the population much larger than their actual numbers, which are now approximately one fourth of the total.

The status of the native population, political, economic, and social, is rapidly improving and will continue to improve steadily if the process is not reversed by bureaucratic ukase.

For the change in attitude toward Alaska on the part of the federal authorities has been more than matched by a corresponding change in the attitude of Alaskans. Within the past ten years Alaskans have established a full-time Department of Health and have begun a battle against long-neglected disease which, in itself, caused the native population to be stationary. The incidence of tuberculosis in Alaska, which among the native population is ten times that in the United States, is further evidence of federal neglect. It should be said, however, that federal participation in the program, though far from adequate, has nevertheless improved substantially owing to the untiring devotion and militant advocacy of our territorial commissioner of health.

The territorial legislatures have likewise established a Department of Agriculture, which aims to supplement the federal program and, as far as possible, compensate for its deficiencies depending upon congressional changes of attitude. The Territory has created a Department of Fisheries, which, although denied the right to share in the conservation policies, nevertheless seeks to supplement the execution of those policies, where its inadequacies persist. Recent legislatures have also given more support to one of the Territory's older agencies, the Bureau of Mines. The territorial government has set an outstanding example of concern for its veterans, passing at a special session, called for the purpose in 1946 immediately after the ending of World War II, an enlightened act which, with a minimum of red tape, enables veterans to acquire homes and businesses.

The Territory's performance in the field of elementary education has been creditable. Nearly 40 per cent of the territorial revenues have on the average been dedicated to it. Throughout the past decade no budgetary request of the commissioner of education has been rejected or reduced. The Territory has assumed the additional financial burden of taking over schools of southeastern Alaska formerly conducted by the Alaska Native Service. And, finally, it has set a high standard of recognition for the teaching profession. Teachers' salaries have been increased in each of the past six regular sessions of the legislature. In consequence, the securing of good teachers in Alaska has not been the problem it has been elsewhere.

Of Alaska's many bottlenecks none has been more retarding than lack of housing. But in the past two years, the Alaska Housing Authority, established by the Legislature eight years ago, has, in collaboration with federal housing agencies, achieved substantial gains. Nearly every community has new housing in actuality or in prospect.

An airport program supplementing the federal program has been carried out energetically and successfully by the territorial Department of Aviation established two years ago. In that short time more than seventy fields and installations have been built (some with federal funds some without) enlarged, or improved.

But, most, important of all, territorial finances are on a sound and firm foundation. For years, and, indeed, until very recently, an adequate revenue structure in the Territory was nonexistent. Individuals and many industries, deriving substantial profits from the Territory, paid no taxes whatever. It is an astounding fact that such important categories of our economy as transporta-

tion, (maritime and air), the construction industry (which received a tremendous bonanza incident to the defense program of World War II), banks, motion-picture theaters, oil companies, newspapers, radio stations, and apartment houses paid no taxes whatever to the Territory. Attempts to alter the existing patchwork were strongly and effectively resisted by the lobbyists of absentee interests. It was not unnatural that those who viewed Alaska merely as an area from which to take, leaving as little as possible, should resist these efforts. This, too, was an inevitable part of the combination of circumstances that had kept Alaska stagnant. Alaska, since its acquisition by the United States, had poured over $3,000,000,000 into the national economy from its fisheries, minerals, and furs. But little or none of that has been invested in Alaska for its development.

This antiquated tax patchwork, with its reliance upon fixed fees and levies on the basis of units of physical output, proved to be completely unresponsive to the phenomenal economic events of the past decade. Although millions of dollars were being spent in the Territory, and the income derived therefrom and from the exploitation of Alaskan resources increased manyfold, the Territory's own income remained pegged at immediate prewar levels. For the six years from 1941 to 1946, the biennial yield remained almost constant at about $4,500,000! Vast sums were lost to Alaska which could have built schools, hospitals, and roads.

Now all that has been changed. Two years ago, the 19th territorial Legislature, wrote perhaps the most important chapter in Alaska's experience in self-government. It adopted a comprehensive, though moderate, tax program. It adopted a program under which no one is taxed excessively, but in which all elements deriving profit and benefit from the Territory contribute reasonably to the maintenance of essential public services.

The reforms that introduced equity into Alaska's tax structure also introduced the important element of flexibility. The old fish pack tax based upon quantitative output was replaced by a more comprehensive fish-processor tax based on *value*. The hit-or-miss schedule of fixed-fee licenses on certain activities gave away to a uniform license tax geared roughly to gross income, and finally the most important element of a modern tax system, a graduated net income tax based on the federal system—a unique Alaskan contribution to tax law—was introduced to Alaska. The results were amazing. Although the rates of levy were modest, the yield for the 1949–50 biennium was nearly seventeen million dollars (in spite of the delays in collection caused by litigation), more that three and a half times the average biennial yield of the old system for 1941–46. Collections for the first eight months of 1951 are reported by the tax commissioner as more than nine and a half million dollars —more than double the yield of the old system for a period of twenty-four months.

That, concomitant with awakened federal interest, marks a complete turn in the road toward Alaska's destiny. The two programs, federal and territorial, are necessarily inseparable. Of what good the expenditures of substantial sums by the federal government unless a fair share is returned for the benefit of Alaskans and for the future growth and welfare of their community? A new generation of Alaskans, Alaskan-born, enthusiastic about Alaska, is growing up. Permanence is replacing transience. Moreover, the newcomers to Alaska are coming with a different purpose from those of half a century ago. Many are veterans, and they come with the hope of staying in Alaska. They are the bearers of the oldest American tradition—the westward trek to found a home for themselves and their children in a land of greater freedom and opportunity.

Changes in the economy of Alaska, needed changes, are at hand. It has been correctly pointed out that the economy of Alaska was lopsided. It depended chiefly on short seasonal programs—the fisheries along the coast, the mining in the interior. The coming of a long-awaited great pulp industry in southeastern Alaska changes all that. Alaska has of course received a great impetus through the vast defense program, long overdue, still not adequate, but representing a complete change from its total absence a scant twelve years ago. A network of roads is being developed in the interior, although roads are as yet virtually nonexistent in southeastern Alaska, a contrast which may be partly explained by military needs, and partly by the conduct of the programs in these two areas by two different federal agencies.

Thus the period of the last decade may be denominated as the era of increasing federal concern and interest, and synchronously the era of Alaskan awakening. It is the era in which Alaskans asked for a statehood and received the heartening echo of nation-wide support. The Alaskan Science Conference of last year, and the second conference, this year testify to the permanence of that change. Alaska has been discovered, forgotten, and rediscovered several times under American rule. I think it may reasonably be forecast that the last rediscovery will be permanent. It is still in its beginnings. But the road ahead is clearly marked. It

will lead, I am confident, to the fulfillment of Alaska's destiny. That destiny, as I said in my address at the first science conference, is to be, in material development, in ideological concept, and in competent performance, the bastion of our continent. It is more than appropriate that that destiny should be fulfilled in an area that once belonged to a nation whose rulers today seem determined to establish tyranny on earth.

It is an inspiring challenge to us to establish on this side of Bering Strait, in the clear view of all mankind, a shining example of our way of life, of government by consent of the governed, of the attainment of that trinity of goals which our forefathers proclaimed as man's inalienable right—"life, liberty and the pursuit of happiness."

Alaska's political ecology has exemplified, and vividly illustrates, all the errors, all the efforts, all the hopes and despairs, all the strivings and failures and successes of free men. It has begun to demonstrate, and will, I am confident, increasingly demonstrate, that the way of freedom is the only way. It will make clear anew that free men, determined to remain free, can surmount natural obstacles, compose their differences, and establish permanently in these far northern latitudes, as elsewhere under the American flag, the dignity, worth, and equality of human beings.

New Books Received

The Invertebrates: Acanthocephala, Aschelminthes, and Entoprocta. Vol. 3. Libbie Henrietta Hyman. vii + 572 pp. Illus. $9.00. McGraw-Hill, New York. 1951.

Laboratory Manual for General Zoology. (2nd ed.) Tracy I. Storer. viii + 150 pp. $2.50. McGraw-Hill, New York. 1951.

Evolution. (2nd ed.) A. Franklin Shull. ix + 322 pp. Illus. $5.00. McGraw-Hill, New York. 1951.

Genetics in Ophthalmology. Arnold Sorsby. xi + 251 pp. Illus. $9.50. Mosby, St. Louis. 1951.

The Infectious Diseases of Domestic Animals. (2nd ed.) William Arthur Hagan and Dorsey William Bruner. xxx + 920 pp. Illus. $8.00. Comstock, Ithaca, N. Y. 1951.

Dictionary of the Arts. Martin L. Wolf. xiii + 797 pp. $10.00. Philosophical Library, New York. 1951.

A Concise History of Astronomy. Peter Doig. xi + 320 pp. $4.75. Philosophical Library, New York. 1951.

Clinical Sonnets. Merrill Moore. 72 pp. $2.50. Twayne, New York. 1949.

Decompression Sickness. National Research Council. xii + 437 pp. Illus. $8.50. Saunders, Philadelphia. 1951.

Diabetes Mellitus. Garfield G. Duncan. xx + 289 pp. Illus. $5.75. Saunders, Philadelphia. 1951.

Comparative Anatomy of the Vertebrates. Theodore H. Eaton, Jr. viii + 340 pp. $4.00. Harper, New York. 1951.

The Pectic Substances. Z. I. Kertesz. xvi + 628 pp. Illus. $13.50. Interscience, New York. 1951.

Radiologic Physics. (2nd ed.) Charles Weyl and S. Reid Warren, Jr. xix + 491 pp. Illus. $10.50. Thomas, Springfield, Ill. 1951.

Forestry in Farm Management. R. H. Westveld and Ralph H. Peck. (2nd ed.) Rev. by R. H. Westveld. xi + 340 pp. Illus. $5.00. Wiley, New York. 1951.

Soil Survey Manual. Soil Survey Staff, Bureau of Plant Industry, Soils and Agricultural Engineering. vii + 503 pp. $3.00. GPO, Washington, D. C. 1951.

Magnetic Materials. F. Brailsford. ix + 156 pp. Illus. $1.50. Wiley, New York. 1951.

Biological Actions of the Adenine Nucleotides. H. N. Green and H. B. Stoner. xvi + 221 pp. Illus. 25*s.* H. K. Lewis, London. 1950.

An Introduction to the Chemistry of the Silicones. (2nd ed.) Eugene G. Rochow. xiv + 213 pp. $5.00. Wiley, New York. 1951.

The Quantitation of Mixtures of Hemoglobin Derivatives by Photoelectric Spectrophotometry. Francis T. Hunter. xi + 226 pp. Illus. $8.50. Thomas, Springfield, Ill. 1951.

The Chemical Activities of Bacteria. (3rd ed.) Ernest F. Gale. 213 pp. Illus. $2.50. Academic Press, New York. 1951.

Basic Organic Chemistry. J. Rae Schwenck and Raymond M. Martin. ix +323 pp. Illus. $4.50. Blakiston, Philadelphia. 1951.

Preparation, Properties, and Technology of Fluorine and Organic Fluoro Compounds. Charles Slesser, Ed. xxiii + 868 pp. Illus. $10.50. McGraw-Hill, New York. 1951.

The Preparation of Programs for an Electronic Digital Computer. Maurice V. Wilkes, David J. Wheeler, and Stanley Gill. 167 pp. Illus. (No price given.) Addison-Wesley, Cambridge, Mass. 1951.

Quantum Mechanics of Particles and Wave Fields. Arthur March. x + 292 pp. Illus. $5.50. Wiley, New York. 1951.

Tensor Analysis for Physicists. J. A. Schouten. x + 275 pp. Illus. $6.00. Oxford University Press, New York. 1951.

Wavelength Tables of Sensitive Lines. L. H. Ahrens. 86 pp. (No price given.) Addison-Wesley, Cambridge, Mass. 1951.

Fundamentals of Electronics. F. H. Mitchell. xi + 243 pp. Illus. (No price given.) Addison-Wesley, Cambridge, Mass. 1951.

An Introduction to Acoustics. Robert H. Randall. xii + 340 pp. Illus. (No price given.) Addison-Wesley, Cambridge, Mass. 1951.

Die Sonnenkorona. M. Waldmeier. 270 pp. Illus. Clothbound, 28.60 Fr. Paperbound, 24.60 Fr. Druck von E. Birkhäuser & Cie, A. G., Basel, Switzerland. 1951.

Radiochemical Studies: The Fission Products. Books 1, 2, 3. Charles D. Coryell and Nathan Sugarman, Eds. 2086 pp. Illus. $18.50 per set. McGraw-Hill, New York. 1951.

SCIENCE ON THE MARCH

PROTEIN STRUCTURE STUDIES

THE chemists of the world, and even more particularly the biochemists, are deeply interested at the moment in the fact that Linus Pauling and Robert B. Corey, at the California Institute of Technology, have recently published a series of papers which, apparently and in all probability, recount the first major successes in the long job of determining the actual space configuration of the atoms that form protein molecules.

Why is this a really important discovery? Why do we care so much about knowing the precise and detailed structure of proteins? As a necessary part of the background for answering these questions, let us review certain facts concerning proteins.

Protein is the chemical name for a certain class of molecules. First of all, they are large molecules—in fact, very large. Whereas a molecule of table salt contains only two atoms (one of sodium and one of chlorine), a molecule of water three atoms (one of oxygen and two of hydrogen), and a molecule of ordinary sugar 45 atoms (12 of carbon, 22 of hydrogen, and 11 of oxygen), protein molecules contain thousands or even millions of atoms.

Proteins are molecular structures that are built out of a very few kinds of atoms—chiefly, in fact, out of only four kinds. On a rough average proteins are (by weight) half *carbon,* a quarter *oxygen,* a sixth *nitrogen,* and a fourteenth *hydrogen.* In addition to these four elements, many proteins have just a little sulfur, a few have a little iodine, and phosphorus and iron are also sometimes involved.

Proteins are not made in all conceivable ways out of the elements just named. They are, so to speak, made in two successive factories. The first is a basic parts factory. There atoms of the elements named above are used to make up some 23 (or possibly two or three more) standard parts, each of which is called an *amino acid.* The amino acids are (at least apart from a very few doubtful cases) well defined, accurately known, and relatively simple combinations of some 10–20 atoms.

A second factory, which is really an assembly plant, accepts large quantities of these 23-odd kinds of standard parts and combines them into huge molecules, which are then called protein molecules.

In other words, every protein is built up out of amino acids. This fact was discovered by the German chemist Emil Fischer in 1900. Since the number of different amino acids is just about equal to the number of letters in the English alphabet, it has sometimes seemed useful to compare proteins to words, spelled out of amino acid letters. If only a few amino acid letters are joined together, the syllable that results is called a peptide. A long syllable is called a polypeptide.

Obviously, one can make an enormous number of words out of 26 letters, and still more is it true that there can be an enormous number of proteins. Actually, this is an analogy that will not bear too close an examination. Words, at least in the ordinary sense, have to be of reasonable length, usually should be pronounceable, should have at least one vowel per syllable, are purely linear arrays of letters, etc. But the analogues of zzzzzzzzzqqqqttttttt . . . and so on, up to thousands of letters, might perfectly well be a good protein.

Astronomical numbers are not the sole property of the cosmologists. A protein containing 200,000 atoms, corresponding roughly to 10,000 amino acid units, is not at all one of record-breaking size. But how many different, purely linear arrays of 10,000 units each can be made if we have 23 different sorts of units? The answer is $10^{13,600}$. This number is vastly larger than the total number of elementary particles in the universe, so that, just from the point of view of potential variability, it is thinkable that each individual particle in the universe could have associated with it not one, but actually a whole battery, of privately designed proteins, each especially tailored to meet some one requirement of that single particle. This substance is indeed protean, as well as protein.

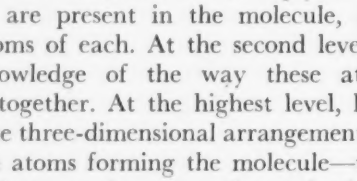
The sort of protein described so far is more accurately called a *pure* protein. If a pure protein is joined intimately to a nonprotein group of atoms (a nucleic acid, for example, or a carbohydrate), then this second nonprotein is called a *prosthetic group*; and the combination of it and the protein part is called a *conjugated* protein. Thus *hemoglobin* is a conjugated protein, *globin*

being the protein part, and *heme* the prosthetic group.

When one seeks chemical knowledge about a molecule, there are at least three important levels of information. At the lowest level, one simply knows *constitution*; that is, he simply knows what elements are present in the molecule, and how many atoms of each. At the second level, he has some knowledge of the way these atoms are grouped together. At the highest level, he knows the precise three-dimensional arrangement in space of all the atoms forming the molecule—the exact distances between the atoms, the angles formed by the lines joining them, etc.

One of the important and almost universally occurring amino acids is *histidine*. At the first level just described, one would write the so-called *empirical* formula, stating that histidine is $C_6H_9O_2N_3$, meaning simply that a histidine molecule contains six atoms of carbon, nine of hydrogen, two of oxygen, and three of nitrogen.

At the next level, however, one would write the so-called *structural* formula for histidine, as



This symbol also says that there are six carbon, nine hydrogen, two oxygen, and three nitrogen atoms in a molecule of histidine. But it says far more than this. It reveals the way the atoms in histidine are grouped together. It tells the chemist that this amino acid contains a five-membered ring, which he called an *imidazole* ring; and that the side chain contains the amino group NH_2, the carboxyl group COOH, etc.

This symbol gives information about the actual molecule not wholly unlike what one would learn about a house from a very conventionalized plan drawing. But it falls far short of telling just how the 20 constituent atoms are actually arranged *in space* to form the histidine molecule. When we speak of the *structure* of a protein, we refer to the third and most complicated level of description; to a description that furnishes an accurate and detailed knowledge of the actual three-dimensional configuration in space of the atoms forming the protein molecule in question.

With this much background of understanding as to what a protein is and what we mean by the structure of a protein, let us see where in nature proteins occur, and what roles they play. To the man who finds it necessary to keep an eye on his waistline, the word "protein" is likely to suggest the meat-egg-cheese portion of his diet. But this is much too superficial, and vastly too restricted.

"All that association of phenomena which we term life is manifested only by matter made up to a very large extent of proteins, and is never exhibited in the absence of these substances."* The wool, leather, and silk that clothe us are largely protein, as are the skin, hair, nails, hoof, horn, feathers, and scales which form a more intimate protection for so many living things. Proteins are the fundamental constituents of muscles, tendons, and connective tissue; they are a part of nearly every organ and enter into nearly every vital process. They form a principal component of the chromosomes that govern our heredity; they are basic building materials for the protoplasm of each cell of every living thing. Our immunity to many diseases depends upon the mysterious way in which serum globulin, a protein in the blood stream, seems to form specific antibiodies when foreign proteins are introduced. Several of the hormones, including insulin, are protein in nature. Special sensitivities to minute traces of certain proteins cause the unpleasant difficulties that we refer to the allergist. The invasions of certain huge protein molecules, otherwise known as viruses, give us the common cold, influenza, encephalitis, certain forms of pneumonia, and many other diseases. Enzymes—those strange chemical controllers of so many of the detailed processes of the body, those perfect executives which stimulate and organize all sorts of activities without using up any of their own substances or energy—are now believed to be protein in nature. Indeed, many diverse scientists, each with his own special enthusiasms, would be willing to agree that these proteins deserve their name of "first substance."

One of the most interesting aspects of protein research, and one that has only recently emerged, is the indication that certain of these huge molecules exhibit phenomena which we ordinarily consider possible only to living organisms. Thus, viruses "reproduce" when in a suitable environment; and yet the brilliant researches of W. M. Stanley and others have shown that certain viruses which show this property so characteristic of life are almost surely nothing more than huge protein molecules. Indeed, proteins appear to have just that range of complexity necessary to bridge over the gap—or what we formerly thought of as a gap—between living and nonliving material. In their simplest forms proteins are as obviously

* Parsons, T. R. *Fundamentals of Biochemistry*. Cambridge, Eng.: W. Heffer & Sons, 1 (1939).

"dead" as any powder that ever filled a bottle. In their most complex form they are the chief constituent of the pulsating protoplasm which is the very stuff of life. And in intermediate stages of complexity they form molecules fifty million times as heavy as hydrogen which, on the one hand, are chemical substances so pure as to be capable of existing in crystalline form, but which, on the other hand, evince the characteristic vital activity of reproduction. To ask whether these huge molecules are alive is, in the strict semantic sense, to ask a meaningless question.

In spite of the importance the preceding remarks briefly indicate, and in spite of the skill and energy with which proteins have been studied, it remains true that no one has, up to now, had sure knowledge of the structure of a single protein; no one knows why proteins have their manifold and characteristic properties. Two principal sorts of difficulties have hindered progress. On the one hand, protein molecules are vastly complicated, as we have seen, containing huge numbers of atoms that can be linked together in a staggering number of ways. On the other hand, proteins are delicate and are predisposed to change their form and properties. On more robust molecules the chemist can use a variety of strong-arm methods for breaking them into pieces; then from a study of the simpler fragments he can reconstruct an accurate picture of the original molecule. But if such methods are used on protein molecules, the fragments are, so to speak, crushed beyond useful recognition.

The complexity and the delicately changeable nature of proteins are handicaps to the analyst, but these two difficulties must be recognized as inevitable. If it were not for their predisposition to change, the proteins would not be capable of playing the leading roles in so many episodes of life—episodes in which change is so often a defining characteristic. Only substances of great complexity could possibly be versatile enough to perform the large number of highly specialized functions found in the repertory of the proteins. There are some biochemicals, notably the vitamins and certain hormones, which appear to occur throughout nature, each in a single, universal form. Even the fats and many carbohydrates occur in relatively few variants of wide distribution. But proteins are so prolifically numerous and so delicately specific that one can, for example, distinguish by coagulation reactions between the protein constituents of the bloods of two hybrid pigeons that represent only slightly different mixtures of two closely allied species. Similarly, if one examines crystals of oxyhemoglobin prepared from the blood of over two hundred animal species, he finds that the subtle variations in this one protein substance are so plentiful that the crystal forms are alike in no two cases.

The *specificity* of proteins is one of their most amazing properties, and it is absolutely essential to our present purpose that we understand what specificity means. Some atoms or molecules of type A find themselves in the presence of molecules of a second type B. Are they indifferent to each other, or does some sort of interaction occur? If type A is oxygen, then the answer is that, for a very wide class of other molecules B, something does indeed occur. Free oxygen is not a highly selective, or specific, substance. It interacts with almost anything. But suppose that type A is the protein antibody which has been produced in the blood of a rabbit by injecting a certain foreign protein P. Then type A is an amazingly "snooty" and discriminating substance. It does not nod even to the chemical equivalents of the Cabots and the Lodges. It has to do *only* with the *one* particular protein P which originally stimulated its elaboration in the blood.

It would be easy to go on to multiply illustrations of the amazingly precise specificity of proteins. For example, we would be inclined to suppose that blood vessels are blood vessels. But it has recently been found that the walls of the blood vessels in two different parts of the same organ (the kidney) of the same animal exhibit measurably distinct and individually characteristic serological reactions, the difference of course resting upon delicate differences in the proteins in the two locations. Recently George Kistiakowsky has shown that the protein enzyme that breaks down urea simply will not affect other molecules which are such close analogues of urea that they differ only in the presence or absence or location of a single atom. In other words, any conceivable change in the molecular structure of urea makes the resultant compound insensitive to the hydrolyzing action of the exquisitely specialized protein urease.

Furthermore, the specificity of a protein molecule is understandable only through a knowledge of the actual *space structure* of the molecule. Various ideas have been developed in protein chemistry about molecules "fitting" in their surface configurations. One hears the analogy of a "key-and-lock" combination. Indeed, even the biological phenomenon of reproduction has been at times described in terms of an ultimate molecular process involving a protein "template," or "mold," which is used to reproduce a basic pattern of life.

We are, at last, in a position to answer our original question—why is it so exciting and important to determine the exact spatial structure of a protein? Indeed, we can now answer the question very briefly.

Proteins play central and basic roles in practically every aspect of vital processes—reproduction, growth and development, health and disease. The almost countless variety of the instances in which protein reactions are important, and the delicacy and precision with which proteins enter into these reactions, depend upon the fact that there are myriads of kinds of proteins, and that each individual kind is delicately fitted to its special purposes. Furthermore, this vast and accurate specialization of the protein molecules is describable and understandable only in terms of the accurate details of the three-dimensional spatial configuration of the atoms that compose the protein molecules.

Perhaps you are saying, "Well, all this sounds important; but can you tell me a little more concretely how an improved knowledge of protein structure would affect daily affairs in the world I live in?"

First of all, consider health and disease. Only a year or two after we knew the structure of vitamin B_1 (cortisone, etc.) the chemists were able to synthesize relatively cheap carload lots of these hitherto rare and costly items. It is quite reasonable to think of great chemical plants manufacturing all those special proteins now laboriously extracted from animal sources—insulin, certain protein hormones, blood proteins, vaccines, antitoxins, etc.

Second, consider commerce. Why is it that we can now make synthetic rubber, various plastics, etc.? Because we know structure. In the many multimillion-dollar industries which depend essentially on fermentation processes, remember that the chemical reactions are catalyzed by enzymes that are specific proteins.

But third—and isn't this still "practical"?—remember that one of the two key components of protoplasm is protein. The other one consists of nucleic acid, which is another complicated substance whose structure we must someday know if we are to understand the nature of nucleoprotein, the basically self-reproductive molecule that *is* life in its most fundamental aspect. For a molecule of nucleoprotein to be able to reproduce itself in all its vast complexity is the miracle of miracles, and only by first unraveling the complexity of the separate pieces—protein and nucleic acid—can this key question be effectively approached.

This, then, is the answer to the question. Proteins are, from the point of view of the student of life processes, the most ubiquitous of all substances. They are involved in all the myriad details of vital phenomena. They are involved in this way because they are complicated enough so that there can be a specialized protein for every conceivable special job, and they are unstable enough to make them suitable for the ever-changing business of life. Furthermore, suppose that someone asks, "What do you need to know about proteins in order to understand the way they work, in order to be able to synthesize certain important ones, in order ultimately to bring certain undesirable aspects of their activities under control?" The answer, of course, is that you want to know everything about proteins. But recognizing what we already know, and appreciating what is vital to know next, the answer surely would be structure.

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BOOK REVIEWS

THE STORMY PETREL OF FORESTRY

Bernard Eduard Fernow. Andrew Denny Rodgers III. xx + 623 pp. $7.50. Princeton University Press, Princeton, N. J. 1951.

IN 1851 there was born on a palatial Prussian estate an aristocrat who became the "father of forestry" in this country. Trained in the meticulous and autocratic forest schools of Germany, he landed in 1876—in a country as innocent then of a science of forestry as he was of the qualities that would make heedless America listen to one of the most remarkable and unfortunate of immigrants.

The very defects of Bernard Eduard Fernow's virtues are reflected in the ill-starred ventures that withered in his hands. No one can say today that the fiasco at Cornell was Fernow's fault, but many think that more tact and less autocracy might have smoothed over a situation that resulted in Cornell having to this day no separate school of forestry. He became the most controversial figure in forestry in this country and in his closing years, in Canada.

Fernow was no failure although so many things he tried ended in acrimony. His technical equipment was superb. He was scholarly and proficient, but with a fatal genius for saying precisely the right things in the wrong way. It is almost literally true that there would have been no forestry in this country for many years if Fernow had not slaved at the old Department of Agriculture on a pittance, long before the U. S. Forest Service was established. It was Fernow who induced Pinchot and Graves to study in the German school. He was their inspiration, their friend in youth as he was to many others who were to make forest history for a country that had none until he arrived. But it was Pinchot—not Fernow—who became the first U. S. Forester, and Graves who became the head of the Yale Forest School.

The life of such a pioneer must have been extraordinarily colorful, for he was in the vanguard of that intrepid band of enthusiasts who finally put forestry across to an indifferent and woefully extravagant country. Hardly a hint of that color and drama appears in Rodgers' book. One has to inch his way through interminable asides, to wander in many shadowy glades of forest history, to get at the kernel of Fernow's outstanding contributions to it.

A biographer must, to make his protagonist a living entity, distill from the record some picture of the man, some reason why he selected him. The book under review is, in this sense, not a biography at all, but the materials for one. It is enormously diffuse, extraordinarily well documented, thoroughly indexed, and perhaps the best record of the history of forestry at the turn of the century that has been written.

But as to Fernow the man, with his immense technical background, his love of music and dancing, there is only a brief note. The reviewer, who was sent by the New York Botanical Garden, as a cub botanist, on one of Fernow's few tropical expeditions, likes to think of this great man (and he was really great) in a somewhat more human role. In a wet rain forest in eastern Cuba, this Prussian aristocrat, with a typical German mixture of autocracy and romanticism, would sit by the fire in the evenings singing at the top of his lungs airs from *Tannhauser* and *Lohengrin* and talk half the night of Schiller and Goethe.

Mr. Rodgers, who aspires to be the biographer of botanists, should remember that biography is not a mere record of dates, names, places, and people, however important and necessary. These are the framework, and upon them one should aim to rear a biography as compelling as Strachey's *Queen Victoria* or as absorbing as the more recent *Roosevelt and Hopkins* of Robert E. Sherwood.

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FROM SEED TO SUGAR BOWL

Beet-Sugar Technology. R. A. McGinnis, Ed. xiv + 574 pp. Illus. $10.00. Reinhold, New York. 1951.

THIS handbook admirably gives the know-how of sugar-beet production and beet-sugar manufacture in United States. "Technology" is equated with applied science as opposed to an older usage that restricts the term to systematic knowledge of an industrial art. Usage of sugar-cane and sugar-beet researchers is in full accord with this trend in terminology since they designate their scientific organizations, comprising both agricultural and processing groups, as societies of technologists.

The editor has called upon thirty-eight other specialists as contributing authors for chapters or portions of chapters and has himself written the historical account of the sugar beet in the United States, is author of an orientation chapter on processing, and of four other chapters, either in whole or in part, on factory methods.

About one sixth of the text deals with sugar-beet agriculture and sugar-beet storage. The rest of the book gives in detail modern methods of beet-sugar manufacture and by-product recovery. The four appendices are: a glossary of beet-sugar factory terms; sample contracts between processor and grower; laboratory thickening test sample data and calculation; and a bibliography of books relating to sugar beets and beet sugar. Both author and subject matter indices are included. This reviewer does not have competence in the field of factory processes and can merely call attention to the completeness with which the subject matter of beet-sugar manufacture

is covered—diffusion, purification, carbonation, filtration, evaporation, and crystallization. Freshness of approach and up-to-dateness in report on techniques and manufacturing equipment characterize all presentations. The newer developments of our recent factory installations are described and pictured. As the editor points out in the preface, the various chapters of the book have been reviewed by a galaxy of authorities—leading technologists of the industry—so that the text has been given exceptional scrutiny, especially on the industrial chemical phases. The sections dealing with sugar-beet agriculture, although brief, are quite acceptable. There is a Western, or California, slant to the presentations which, in view of the fields of experience of the various authors, is to be expected; the excursions into plant physiology and plant histology may slightly grieve the botanical purist.

The book is written largely by young men, and this gives it vigor and freshness but also contributes a fault or two. It is understandable that those who have not known the vicissitudes of the beet-sugar industry since 1912 may not properly evaluate the seriousness and the impact of plant diseases. Plant diseases made the factories lead a gypsy existence—witness the editor's tabulation of factory odysseys in his Table 1–1. Large segments of the industry were brought essentially to bankruptcy because of the ravages of curly top, leaf spot, and black root. Against such a historical background, it is disconcerting to note that certain sections of the book appear not to appraise properly the contribution of disease-resistant varieties.

Slips such as these—a misspelling or two, an awkward phrase here and there—are, however, minor flaws in this valuable, helpful book. The editor and the contributors are to be congratulated upon a thoroughly readable and an effective presentation.

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THE WORM IN THE APPLE

Insects as Human Food. F. S. Bodenheimer. 352 pp. Illus. Dutch guilders 10.–. W. Junk, The Hague, 1951.

THIS is one of the many contributions by the author in the field of entomological history and is up to the high standard of completeness and exactness shown by Dr. Bodenheimer in his great two-volume work *Geschichte der Entomologie,* printed by Junk in 1928–29.

Among the introductory remarks are the following: "Insects as human food have often provoked curiosity. But only recently has this topic been recognized to be of major importance in the nutrition of primitive man, especially in tropical countries." The author might also have added that in recent years legal steps have been taken by government agencies, particularly in the United States, which are aimed to protect the health of human beings by setting up tolerances limiting the number of insects or their fragments in certain agricultural food products that become infested during growth. Such regulations are intended to remove the insects, and they entail a tremendous amount of work on the part of the farmer to control or virtually exterminate them in the growing crop. An equally great expense is necessary in carrying out control measures by the use of insecticides or other means in order to market an insect-free product.

Naturally the author does not assume that all kinds of insects have been eaten regularly by either primitive or civilized man. Although there are many unpalatable species, a great many are edible. The pressure of starvation and seasonal scarcities of food to a large extent determined the extremes to which primitive man was forced to eat what might have been objectionable in times of plenty. The poisonous insects, like the poisonous plants, were early recognized and avoided by tradition and custom, just as the consumption of the vast hordes of edible species became the accustomed diets of primitive races the world over. Insects or their products that became important and regular sources of food may be arranged, according to their desirability and availability, somewhat as follows: grasshoppers (in all large continental land masses); termites (in tropical Africa, Asia, Australia, South America); caterpillars of butterflies and moths, grubs of beetles and weevils; the honey of bees and the honeydew of scale insects, aphids, and similar insects; eggs of water bugs (in parts of Mexico and South America); water beetles and water bugs (in China); ants (in many parts of the world); head lice (a practice handed down to this time by humans and the so-called monkey tribes); and of course all other kinds available in particular areas.

The important chapters of Bodenheimer's book deal also with such matters as the general entomophagous habits of early man; the nutritive value of insects as human food; a careful survey of literature relating to the subject from the time of Aldrovandi (1522–1607) to the present. This section begins with a general discussion of tribal habits and superstitions concerning insects and is followed by a discussion from a geographical point of view that includes Australia, Tasmania, New Guinea and Polynesia, Africa, Asia, and the Americas.

The material is presented in a masterly and interesting manner, which I am sure will convince the reasoning reader that insects have been a valuable source of food. The honeybee, in particular, continues to supply man with a nutritious and delicious pabulum that was, in ancient times, considered to be the food of the gods and was for centuries reserved only for the nobility and the wealthy.

Regardless of the ancient benefits, it must be admitted that the use of insects as food is fast disappearing, being replaced by a continuously growing and developing system of farming the land and the sea to give humanity a far more reliable, sufficient, and aesthetic means of obtaining and insuring a more permanent, adequate, and safe supply of food.

Let us bear in mind, however, that insects will probably always share our prosperity and that few of us mortals will ever escape the possibility of occasionally

consuming an aphid in a salad or a worm in an apple. If we think of these extra tidbits as food, we shall not be the loser either in pocket or in health. We might even prefer to eat a few harmless insects rather than a poisonous spray applied to eliminate a lesser hazard for a more serious one.

I hope someone will be thoughtful enough to send a copy of this book to the Pure Food and Drug Administration!

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THE LIFE OF HANS DRIESCH

Lebenserinnerungen. Hans Driesch. 311 pp. Swiss fr. 11.–. Reinhardt, Basel. 1951.

Hans Driesch. Persönlichkeit und Bedeutung für Biologie und Philosophie von heute. Aloys Wenzl, Ed. 221 pp. Swiss fr. 11.– paper; 13.50 cloth. Reinhardt, Basel. 1951.

THE life of Hans Driesch was unusual in several respects. He began his career in zoology, became a *Privatdocent* in Heidelberg in the same year in which his last experimental investigation was carried out, and devoted the rest of his life to the teaching and study of philosophy. He emphasizes in his memoirs that this shift to philosophy was the logical outcome of his experimental work, which proved to him the impossibility of a mechanistic explanation of developmental processes. A few years after he had joined the staff of the university at Heidelberg, he was called to Cologne and later to Leipzig as professor of philosophy.

His work did not remain confined to philosophical questions intimately connected with natural sciences but was extended to logic, metaphysics, and ethics. It is perhaps strange that he became interested in parapsychology, presided at meetings of parapsychological societies in various countries, and published a book on the subject. The invitation to give the Gifford lectures in Aberdeen led to the publication of *Science and Philosophy of the Organism* and started Driesch's career as a lecturer. This led him to practically all European countries, North and South America, China and Japan. As a young man he traveled extensively in Europe and Asia, and his comments on these experiences make interesting reading.

Driesch was born in 1867, attended the Gymnasium in Hamburg, studied in Jena (under Haeckel) and Zurich, and spent many years at the zoological station at Naples. His human contacts were diversified and by no means confined to professional zoologists and philosophers. His writing is not distinguished, but the book gives interesting glimpses into the intellectual and social life of Germany during the past 60 years. In Driesch's opinion the period from 1924 to 1932 was a time of intellectual flowering "rarely seen in any nation." The political events of the Hitler period are touched but briefly. Driesch confesses, however, that in his opinion democratic liberalism is the only political attitude compatible with ethics.

The second book gives a more detailed and critical discussion of Driesch's work. The volume begins with a well-written article by Margaret Driesch on the life and career of her husband. This is followed by an interesting contribution by von Natzmer, in which he shows the influence of Driesch's experimental work and theoretical concepts on various branches of biology, particularly on Speman's work in experimental embryology, studies in genetics and insect physiology, and finally Schrödinger's concepts of the fundamental differences between physics and biology. Schöndorfer discusses Driesch's philosophical achievements, and Wenzl writes a long systematic essay on the present state of neovitalism. Schöndorfer's and Wenzel's contributions are difficult (for nonphilosophers) to read. Both authors discuss the relevant literature. The book concludes with correspondence between Driesch and Mittasch (known for his work on catalysis) and a complete bibliography of Driesch's work from 1889 to 1941. This book is a valuable contribution to theoretical biology.

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SOCIOLOGY SURVEYED

American Sociology: The Story of Sociology in the United States to 1950. Howard W. Odum. 501 pp. $5.00. Longmans, Green, New York. 1951.

IN DISCUSSING classifications of sociology according to national differentiations, Albert Salomon remarked (in *Twentieth Century Sociology,* p. 586) that it would be as ridiculous to speak of German physics as it would be to discuss the characters of American or French philosophies. Since those words were written in 1945, however, it has become increasingly clear that one may speak of German physics, Russian physics, American physics, or Argentine physics, and no longer be ridiculous.

As if in America there were no sociology but only sociologists, the greater part of Dr. Odum's book is given over to the careers of the past presidents of the American Sociological Society, taken in chronological order from its beginning in 1906 with Lester F. Ward, to Leonard Cottrell in 1950. Brief biographical notes are included on each, together with comments on their opinion of the state of sociology in America.

A second part of the book is devoted to a survey of the leading textbooks in sociology and social pathology, or "social problems," and special sociology, such as the community, marriage and the family, ethnic groups, population and regionalism, and "applied social science." This section also includes a chapter on sociological journals, giving brief historical sketches of their foundation and development, and discussing their more prominent editors. Trends in the development of sociology are discussed in a final brief section entitled "Toward Inventory."

Dr. Odum's book contains much interesting biographical data about American sociologists; the book will be particularly interesting to mature sociologists,

especially those active in the affairs of the American Sociological Society. The advanced student, headed for a career in sociology, will be attracted to the book, as it is filled with intimate talk about the great and near great in sociological circles. Particularly interesting, also, is the section devoted to a survey of sociological texts.

Those who are looking for a comprehensive survey of developments of theory and method in American sociology will be disappointed, however, for these matters receive only superficial treatment in this volume. Such a work is sorely needed, both for use as a sociology text and for the enlightenment of those in other fields who want a broader understanding of this, the most synthetic and eclectic of the social sciences. Though Dr. Odum's book fails to meet that need, it does point out the ways in which such a volume should and should not be written.

Selection of men and concepts to be discussed is usually a matter of the author's preference. Dr. Odum, however, with the aid of numerous assistants, has compiled and tabulated the number of sociologists who are most often cited in texts, noting the spread and frequency of their appearance. A sociologist's prestige is in this way measured in terms of "getting his name in footnotes," as an actor's is by the appearance of his name in electric lights. By this method, Dr. Odum was able to determine that the stars of the sociological stage are Park, Burgess, Cooley, Sumner, Ross, Thomas, Giddings, Ward, and Small.

In his own book, however, Dr. Odum does not use this device for selection of the men to be discussed. His decision to include all the past presidents of the American Sociological Society was perhaps unfortunate, if unique, for the work suffers thereby. Had he limited his discussion to the leading sociologists as identified by his own research, a great deal more might have been said about their contributions to the development of sociological theory and method.

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BUSINESS ENGINEERING

Effective Management through Probability Controls. Robert Kirk Mueller. xvi + 310 pp. Illus. $5.00. Funk & Wagnalls, New York. 1950.

THIS book expounds the following thesis: Management of business can be made more reliable and scientific by the use of statistical control. Statistical control consists of (*a*) keeping track *quantitatively* of important variables, and (*b*) taking corrective action when a variable behaves in a manner not explainable by chance (and therefore attributable to an assignable cause). It is well known that statistical control has been applied with great success to improving the quality of industrial products; however, the corresponding advantages to be gained from statistical control in sales, clerical operations, personnel administration, and other management activities are not so well known. This is the aspect of statistical control that the author wishes to place before modern industrial management.

The author illustrates with a great variety of examples how statistical control has been used with success and profit in both the production and the management phase of many companies. This should provide a very convincing argument to the management of those companies that have not yet tried statistical control. In addition, it should encourage the management of those companies that have successfully tried statistical control in *production* to extend it into *management*.

Since the book is intended essentially as a sales talk to management, not too much emphasis is placed on the technical aspects of the underlying statistical theory. However, enough facts are presented about the basic statistical ideas to make the subject meaningful to management. For example, a chapter is presented on how to read and digest a control chart.

Especially valuable is Section V, "Topside Responsibility and Participation in a Control Program." A good deal of useful information is presented about: How to Organize a Program; Time Required to Get Results from a Statistical Control Program; Selection of Personnel to Administer a Statistical Control Program; How to Tell whether a Consultant is Qualified; How to Sell Statistical Control Programs; and Where to Find Out More about Statistical Control.

Although the book succeeds quite well in presenting a worthy thesis, it must be pointed out that there are some misstatements in the presentation of statistical ideas. For example: Page 110: "Stratified sampling is used where equal [?] samples are taken from each of the ultimate groups irrespective of the relative size of each of these groups and the population as a whole." Page 116: " . . . attributes, i.e., things which can be judged only by visual [?] examination."

However, since the book is not intended primarily as an exposition of statistical theory, but rather as an exhortation to management, such errors do not seriously interfere with its purpose. If the book succeeds in its aim, business management will have taken another big step from intuition toward science.

FRANK PROSCHAN

Statistical Engineering Laboratory
National Bureau of Standards

What Happens During Business Cycles. A Progress Report. Wesley C. Mitchell. xxxi + 386 pp. $5.00. Riverside Press, Cambridge. 1951.

BY THE death of Wesley C. Mitchell on October 29, 1948, while he was working on his manuscript of the work that has since been posthumously published as a "progress report" on "what happens during business cycles," our country lost its most eminent and scholarly authority in the study of business cycles. Herbert Hoover is said to have written to him after his severe heart attack a year earlier: "I hear that you are laid up. This is not in the national interest." His death was, indeed, a severe blow to the national interest.

Dr. Mitchell was a pragmatist in his analysis of economic problems, especially those dealing with business cycles. True to his basic philosophy, he actually grappled

with the problems confronting him in business cycle research by utilizing a quantitative-descriptive type of method based on modern statistical techniques.

In his last work Dr. Mitchell did not engage in sweeping generalizations, but characteristically examined many economic processes with the utmost care on the basis of the monumental statistical investigations that were conducted for over a generation by the scholars of the National Bureau of Economic Research under his direction. That business cycles are complex phenomena is borne out by the fact that relatively few economic processes fail to bear their imprint. Moreover, because of their lack of uniformity, economic processes had to be studied in incredibly minute detail by Mitchell and his staff to yield valid conclusions.

It would not be within the scope of this review to detail the many interesting conclusions that were reached by the author. It can only be pointed out that this book embodies the results of five decades of research, and that it is a worthy summation of a lifetime of study. To *Business Cycles* (1913 and 1927 editions), and to *Measuring Business Cycles,* written in collaboration with Arthur F. Burns in 1946, can now be added another brilliant volume in the majestic Mitchell manner.

HARRIS PROSCHANSKY

New York

BRIEFLY REVIEWED

The British Amphibians and Reptiles. Malcolm Smith. *The New Naturalist,* Vol. 20, 318 pp. 21/–. Collins, London. 1951.

MALCOLM SMITH has added many enviable innovations in his complete treatment and last word on British herpetology. The book is lavishly illustrated with 18 excellent color photographs, 33 photographs, 5 drawings, and a distribution map for each species.

The editor's preface tells of Mr. Smith's eminent abilities as a naturalist, and the author's preface tells us that this is the first general work on British herpetology since Bell's monograph, published one hundred years ago.

Chapter 1 is a general history of herpetology, which it behooves any herpetologist to study. It also deals with the difficulty of introducing species and the disappearance of the pond turtle as a result of changing climatic conditions. Each chapter of the body of the book treats the seven families as groups, beginning with well-illustrated descriptions of their physiology, followed by a description of the species, covering habits as well. The yearly cycle is shown in a clever circular calendar which gives dates of hibernation, mating, and other events of the life history. Chapter 7 is a brief account of the marine turtles which have stranded on the shores. Each record is shown on a map.

Chapter 8 covers parasites, internal and external, but gives no treatment for them, as this is not a book for vivarium keepers. The last chapter outlines the great amount of investigation yet to be done to round out complete knowledge of this interesting group. An appendix on classification, a key to the British frogs, a glossary of all terms used in the text, a reference to vice-counties with map, a bibliography, and an index follow.

Smith has written a book, which, though strictly scientific, ranks in interest and readability with White's *Natural History of Selborne.*

CHAPMAN GRANT

San Diego, California

The Ape in our House. Cathy Hayes. 247 pp. Illus. $3.50. Harper, New York. 1951.

ABOUNDING as it does in amusing anecdotes, this report on the rearing of a chimpanzee as a daughter in the house will be read by many as humor. Psychologists, however, must acclaim it as a major contribution to science. The object of the study of apes is to determine the true nature of man's superiority. Mrs. Hayes makes it clear with immediate definiteness that it lies in man's ability to speak, but thinks other factors may appear as the experiment continues.

Keith Hayes, research psychologist of the Yerkes Laboratories of Primate Biology at Orange Park, Florida, took Viki when she was a few days' old; he and his wife availed themselves of the best child-training techniques and were ever on the lookout for helpful suggestions. The little chimp was from the beginning equal to children of her own age. She was possessed, however, even at the age of three when the book was written, of hyperactivity and retarded speech. Mrs. Hayes tells of the methods used to form words in Viki's mouth so that the baby learned to say "mama," "papa," and "cup." Meanwhile she tore through the house swinging from curtain rod to cupboard top, breaking china and glass, but usually being sweet, loving, and lovable.

Photographs such as those any man might take of his charming and impish daughter add vividness to the book. Viki's ability to solve problems, her love of clothes, her interest in her work, her toys and games, and her delight in food of all kinds are recorded in pictures and words. "The mere business of living in a house is an education in itself . . . she learned to bulb snatch, to raid my filing cabinet, to core apples with her whistle, and to fingerpaint on the rugs with butter and orange juice."

At three, she has innate intelligence to the same extent as a human child. She has done very well with the "personal experience" component of intelligence. It is in group intelligence, in making use of what others have learned, that she is lacking because of the language barrier. Her story is told delightfully, with emphasis on the pleasure she is and no mention at all of what a trial and care she must be at times. Apparently the Hayes family is a selfless one, willing to give everything to science. In the very beginning of the experiment the pattern was formed: "Viki did it; I observed it; Keith explained it."

MARJORIE B. SNYDER

Washington, D. C.

ASSOCIATION AFFAIRS

THE ALASKA DIVISION*

TO FACILITATE the activities of so broad and inclusive an organization as the American Association for the Advancement of Science, it has been found desirable to organize its members in certain regions on a geographical basis. Thus the Association has branches and divisions, as well as sections, which are based on the several scientific disciplines. The two types of groupings should not be confused. All members and fellows residing in a certain community, regardless of their assignment in sections, may be organized as a branch of the Association. Similarly, all members and fellows residing within a large region may be organized as a division of the Association.

In accordance with this arrangement the Pacific Division, established in 1915, includes members resident in British Columbia, Washington, Oregon, California, Idaho, Nevada, Utah, and the Hawaiian Islands. The Southwestern Division, which was given official recognition in 1920, includes members resident in Arizona, New Mexico, Colorado, Sonora, Chihuahua, and Texas west of the 100th meridian. To these regional organizations we now add the Alaska Division, which includes members resident in the Territory of Alaska. Incidentally, I hope that it will not be long before we can change that designation and say "members resident in the State of Alaska," and I also venture to suggest that the door be left open so that, when it becomes appropriate to do so, the Alaska Division may include members of the Association residing in Yukon Territory.

Significantly enough, the regional organization of scientists inaugurated in Alaska is the first to take full advantage of the arrangements for divisions and branches. From its very start, the Alaska Division will embrace three branches—Cook Inlet, Arctic, and Southeastern—each at a strategic place within the Territory. It appears certain that each of these will rapidly develop into a strong center of scientific progress, and that the Alaska Division will prosper, notably because of the contribution that these local units will make to the extension and dissemination of knowledge.

The Alaska Division, like the two older divisions, will have full control of its meetings and its affiliations with other scientific organizations, conducting its affairs within the broad scope of the Association's objectives as it shall deem desirable. To help the division meet its necessary expenses, an annual allotment, not to exceed one dollar for each of its members in good standing, will be made from Association funds. This large measure of autonomy places a heavy responsibility upon the local management of the division and branches, and indicates the confidence already inspired among the members of the AAAS Council and Executive Committee. Our expectations are high. We will render whatever assistance we can, but the job of making the Alaska Division what we expect it to be is a local responsibility.

So much for my official duties; now a few words of personal opinion and unofficial views.

In my mind, the establishment of the Alaska Division is like the setting up of a milestone that marks an important point in the path of scientific progress. For many decades, outstanding scientific work has been done in this region, but it was done almost exclusively by scientists who spent only a small fraction of each year in the field and then returned to the States to analyze the results of their observations and prepare their reports. As a geologist, it is only natural that I should recall the many significant contributions to knowledge made by scores of eminent geologists from the United States Geological Survey and from the departments of geology in a dozen or more American universities. Indeed, it was my own privilege to spend a summer, many years ago, investigating the geological features and resources of a part of the Alaska Peninsula in the general vicinity of Kamishak Bay, as a member of the USGS. My party was put ashore in the bay late in June. Working inland and to the westward, we were completely cut off from any contact with the outside world for more than two months. At last, early in September, we reached the little coastal settlement of Kanatak, which was just

* Based on an address at the second Alaskan Science Conference, Mount McKinley Park, September 4, 1951. As president of the AAAS, Dr. Mather formally installed the Alaska Division of the American Association for the Advancement of Science. The establishment of this newest geographical unit as an integral part of the Association was authorized by the Executive Committee on June 30, 1951, following a vote of approval by the Council. Officers of the three branches of the division were given in the October issue of THE SCIENTIFIC MONTHLY (p. 254). (Through a typographical error the *Southeastern* Branch was incorrectly spoken of as the "Southwestern.")

being deflated after a brief boom resulting from abortive efforts to find petroleum in its vicinity. From a radio station there we got the first news of what had been happening elsewhere in the world that summer. Three items were promptly reported to us: President Harding had died in San Francisco, following his return from a visit to Alaska; a disastrous earthquake had practically destroyed Tokyo and devastated a large area of Japan; and Jack Dempsey was still heavyweight champion of the world. That of course dates the year as 1923.

At that time there was not a single, well-equipped, adequately staffed, permanent research station in the entire Territory. Scientists conducted exploratory expeditions, but very few of them expected to make Alaska their permanent home. Probably fewer than half a dozen resided anywhere within the Territory. But that has largely been changed in the past twenty-five years. Today, Alaska has many notable research institutions that are just as indigenous as those in any of the states. Scientists think of Alaska as a vital, integral part of the United States, rather than as a foreign land that happens to be among our possessions.

The importance of Alaskan resources in the economy of the nation is not, however, as widely realized as it ought to be. The mineral wealth and agricultural potentialities of the Territory are actually among our strongest assets for the future. The complex geologic structures in widely separated districts supplement admirably those within the forty-eight states, and well-nigh double the possibility that domestic supplies of needed minerals will be adequate for the nation's economy. Already the platinum derived from Alaskan mines has gone far toward bridging the gulf between supply and demand, which resulted from curbing the imports of that metal from the Soviet Union.

It would be surprising if the United States should ever become self-sufficient with regard to mineral resources, even with those of Alaska added to those of the forty-eight states. The demands of modern industry for raw materials have become so diversified that they must be brought to manufacturing centers from hundreds of different types of mineral deposits, many of which are present only in foreign lands. Mineral interdependence among the nations of our well-stocked earth is one of the most significant facts of life at the midpoint of the twentieth century. From a strictly geological viewpoint, it is now evident that the earth is far better adapted for occupation by men organized on a world-wide scale, with maximum opportunity for free exchange of raw materials and finished products, than it is for occupation by men who insist upon building barriers between regions even so inclusive as a large nation or an entire continent.

That men have not followed this directive, implicit in the structure of the earth, makes all the more necessary the exploration for certain types of ores that may be found in Alaska, to supplement those already available within the United States. We are the largest consumer among the nations of the world for almost every item on the long list of mineral resources, but we are at the bottom in production of certain of those items, and far below the top for many others. Although it is extremely unlikely that supplies of nickel, tin, cobalt, or uranium, adequate to meet America's ever-expanding needs, will be found in Alaska, it is possible that extensive ore bodies of antimony, chromium, tungsten, copper, lead, and zinc are present, to contribute greatly toward meeting the requirements of the not-distant future. The challenge to Alaskan geologists and metallurgists is obvious.

Many Alaskan scientists are engaged in research in one or another of the many aspects of the biological sciences—economic botany, animal husbandry, public health, etc. Here I promptly confess my own profound ignorance. I know just enough to recognize the unlimited opportunities for scientific achievements that lie ahead, as well as the significant advances made in recent years. In broad perspective the problems are those of adjustment of human welfare to the peculiar characteristics of the environment afforded by this vast and diversified land. Most of the problems call for the cooperation of scientists with a considerable variety of specialized knowledge and interests. Coordinated studies and teamwork are essential to success. Here, of course, is one of the basic reasons for the organization of scientists such as is being perfected in Alaska. To find the best balance between planned research and individual initiative is not easy, but both are essential, and I have confidence that men and women of intelligence and good will, thoroughly committed to what we know as the democratic way of life, will find it.

Indeed, it seems to me that Alaskan scientists, still pioneers in a rich, new land that has only begun to be developed, have a unique opportunity to set an example for the rest of us in this particular regard. The inertia of established institutions and time-hallowed methods is relatively slight. The procedures devised for cooperative enterprises and

coordinated research will be watched with great interest by all who are concerned with the strategy and tactics of science in these days of crisis for all mankind.

There is another reason, and perhaps it is the most important of all, why science in Alaska will be in a most strategic position during the coming years. Alaska is on the international frontier between the United States and the Soviet Union, the only part of our nation so situated. For this reason the Air Force and other branches of our Department of Defense are especially active in the Territory. Much of the scientific research now under way in Alaska is directly or indirectly related to mobilization for defense and is generously supported with government funds for military reasons. Fortunately much of this military science is of value in peaceful activities as well. Even so, the military atmosphere cannot help but prevail in most scientific circles in Alaska at this time. This, of course, is inescapable and absolutely necessary as long as the present state of dangerous tension continues between Russia and the United States.

Nevertheless, it is the duty of scientists to look beyond the present emergency into the latter half of the decade of the fifties. The ideology of Communism cannot be destroyed by bombs and bullets. Military power can restrain military aggression, but only a better ideology can win the victory in the competition between conflicting ideas and ideals.

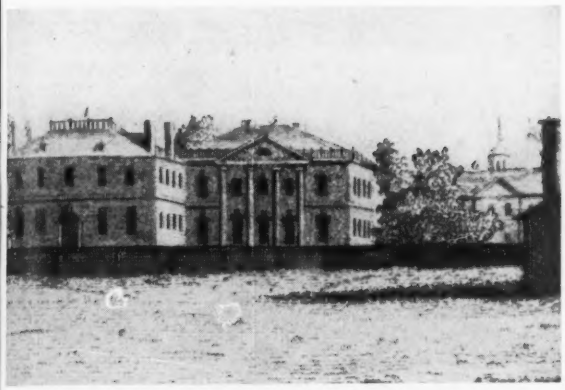
Alaska may well prove to be one of the most important testing grounds for democracy. Here may be the place where Americans will demonstrate most effectively to Russians the supreme value of the American way of life. In spite of the Bering Sea and the impenetrability of the Iron Curtain, the people of Russia will know a great deal about what is going on in Alaska. They will be particularly interested in the way the Aleuts and other natives are treated by the white Americans. They will observe carefully the social relations between people of different heritage, as well as the economic conditions of the less advanced groups residing in the area. The scientifically minded citizens of Alaska should take the lead in seeing to it that democracy is practiced in all aspects of Alaskan life. If that can be done in fact rather than merely in theory, by deeds rather than by words alone, the development of Alaska under American leadership will prove to be one of the strongest weapons available in the conflict of ideas. It may go far to turn the balance in our favor as we compete with the Communists for the minds and loyalties of men throughout the world.

The frontier position of Alaska may be of great strategic importance in the long-range policy that alone can transform the present world of fear, suspicion, and mobilization for war into the much-desired world of freedom, peace, and prosperity. There can be no lasting peace unless friendly relations are somehow established between the people of the United States and the people of the Soviet Union. At the moment, we cannot do very much, if anything, to bring about that result. But every one of us should constantly be alert for any opportunity that may arise in the future. The geographic relations of Alaska and Siberia may bring such opportunities, earlier than one might now expect. Certainly it is not too soon to begin to develop an attitude of mind and a restraint of emotions that will ensure a readiness to take friendly steps and display kindly gestures when opportunity comes.

All this means that every scientist—whether working in the physical, the biological, or the social sciences—is under obligation to give extremely careful consideration to his personal attitudes and commitments as he seeks to fulfill his duty to his science, his country, his fellow-men and, perhaps most of all, to his own best self. If the Alaska Division of the American Association for the Advancement of Science can stimulate among its members a compelling desire to accept the responsibilities and exercise the rights of the citizen in a free society, it will become a power for the advancement of human welfare. Strenuous efforts to direct the application of the intelligence of science should have top priority on the division's agenda throughout each of the years to come. Each member of the division should do his best to demonstrate that he is "a scientist with social conscience."

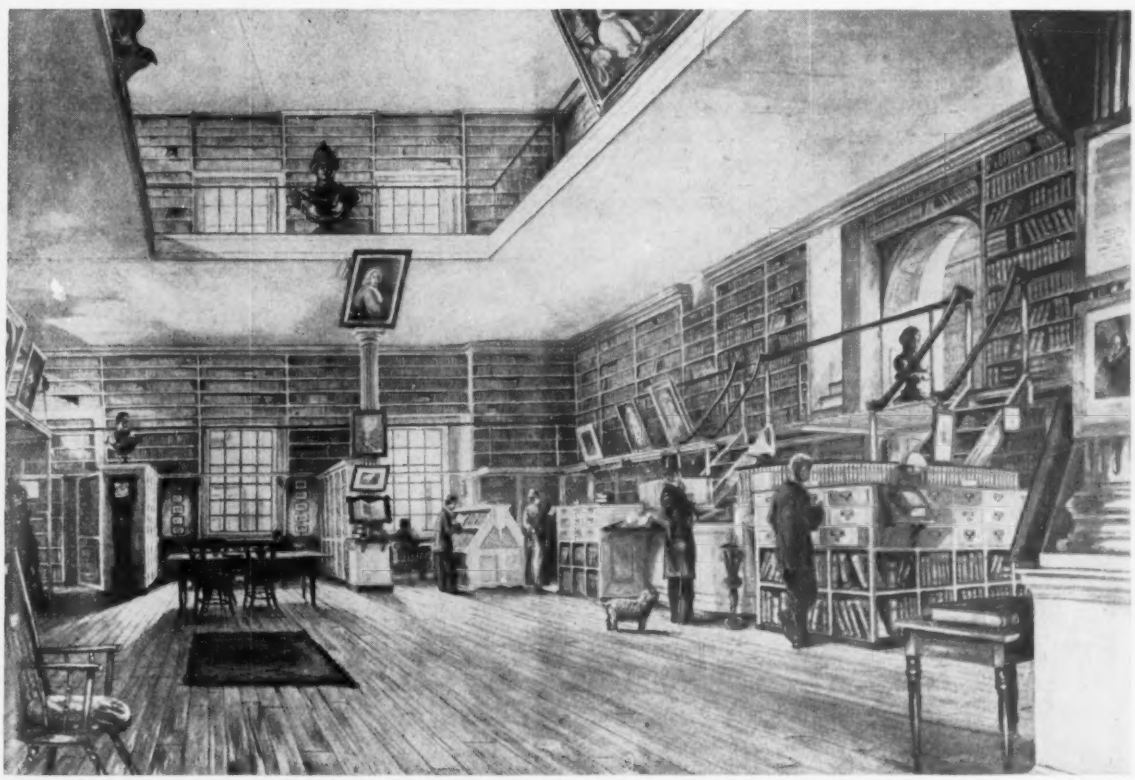
KIRTLEY F. MATHER

President, American Association for the Advancement of Science



Independence Square in 1790 (*above*). From the left: County Court House, the State House, Philosophical Hall, Library Hall, Carpenters' Hall. *Left:* The Loganian Library as it appeared in 1790, at far right of picture. (Both from *The Columbian Magazine.*) *Below:* Interior of Library Hall in 1859. Archway at right leads into the Loganian Library. (Wash drawing by Colin Cooper, courtesy of the Free Library of Philadelphia.)

Illustrations lent by the American Philosophical Society through Thomas D. Cope, whose article on some of the scientific landmarks of Philadelphia's colonial days appears on page 339 of this issue.



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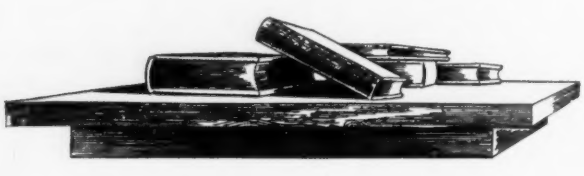

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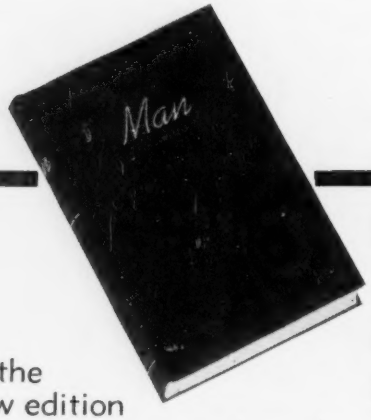

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Meetings

Dec. 2. American Academy of Dental Medicine (Midwinter). Hotel Statler, New York.

Dec. 2–3. American College of Chest Physicians. Ambassador Hotel, Los Angeles.

Dec. 2–5. American Institute of Chemical Engineers (Annual). Chalfonte-Haddon Hall, Atlantic City.

Dec. 2–5. American Society of Refrigerating Engineers (Annual). Hotel Roosevelt, New York.

Dec. 2–5. Vegetable Growers Association of America (Annual). Marlborough-Blenheim Hotel, Atlantic City, N. J.

Dec. 5–8. Philippine College of Surgeons (Annual). Philippine General Hospital, Manila.

Dec. 6. Society of Cosmetic Chemists (Annual). Biltmore Hotel, New York.

Dec. 6–8. American Chemical Society (Southwest Regional). Austin, Texas.

Dec. 6–9. American Psychoanalytic Association (Midwest). Waldorf-Astoria, New York.

Dec. 7–8. Way of Science Conference (Annual). Roosevelt College, Chicago.

Dec. 9–13. Entomological Society of America, American Phytopathological Society, and Potato Association. Netherland Plaza Hotel, Cincinnati.

Dec. 10–11. Southern Psychiatric Association (Annual). Carolina Inn, Pinehurst, N. C.

Dec. 11–19. International Congress on Mental Health. Mexico City.

Dec. 12–15. Society of American Foresters (Annual). Buena Vista Hotel, Biloxi, Miss.

Dec. 14–15. Association for Research in Nervous and Mental Disease. Roosevelt Hotel, New York.

Dec. 20. American Society of Perfumers. Advertising Club, New York.

Dec. 26–31. American Association for the Advancement of Science. Philadelphia.

Dec. 27–28. American Chemical Society (Division of Industrial and Engineering Chemistry, Christmas Symposium). Evanston, Ill.

Dec. 27–29. American Physical Society. University of California, Berkeley.

Dec. 27–30. National Science Teachers Association (Annual). Philadelphia.

Dec. 27–Jan. 2. Institute of General Semantics. Seminar (Winter). Lime Rock Lodge, Lakeville, Conn.

Dec. 28–29. American Speech and Hearing Association (Annual). New York.

Dec. 29. Mathematical Association of America (Annual). Brown University, Providence, R. I.

Jan. 7. Massachusetts Society for Research in Psychiatry. Ring's Sanitorium, Arlington.

Jan. 7–8. American Institute of Electrical Engineers Conference on Electronic Instrumentation and Nucleonics in Medicine. Commodore Hotel, New York.

Jan. 14–18. Society of Automotive Engineers (Annual). Hotel Book-Cadillac, Detroit.

Jan. 16–18. Society of Plastics Engineers (Annual). Chicago.

Jan. 18. Highway Research Board (Annual). National Academy of Sciences, Washington, D. C.

Jan. 21–22. Compressed Gas Association (Annual). Waldorf-Astoria Hotel, New York.

Jan. 21–25. American Institute of Electrical Engineers (Winter). Hotel Statler, New York.

Jan. 23–24. National Industrial Conference Board. Waldorf-Astoria Hotel, New York.

Jan. 26. Mathematical Association of America (Northern California Section). Stanford University.

Jan. 27–31. National Conference on the United Nations and the Specialized Agencies. Hunter College, New York.

Jan. 29–31. American Meteorological Society. Roosevelt Hotel, New York.

Jan. 31–Feb. 2. American Physical Society (Annual). Columbia University, New York.

Feb. 15–16. Mathematical Association of America (Louisiana-Mississippi Section). Northwestern State College, Natchitoches, La.

Feb. 25. Massachusetts Society for Research in Psychiatry. Cushing Hospital, Framingham.

Feb. 28–Mar. 1. National Conference on Rural Health (Annual). Shirley Savoy Hotel, Denver.

Mar. 3–7. American Society for Testing Materials (Spring). Cleveland, Ohio.

Mar. 8. Mathematical Association of America (Southern California Section). Occidental College, Los Angeles.

Mar. 10–14. National Association of Corrosion Engineers (Annual). Galveston Pleasure Pier, Galveston.

Mar. 16–19. American Institute of Chemical Engineers. Atlanta Biltmore Hotel, Atlanta.

Mar. 17–19. Midwestern Conference on Fluid Mechanics. Ohio State University, Columbus.

Mar. 21–22. Mathematical Association of America (Southeastern Section). Georgia Institute of Technology and Agnes Scott College, Atlanta.

Mar. 28–29. Eastern Psychological Association (Annual). Chalfonte-Haddon Hall, Atlantic City.

Mar. 29–30. American Psychosomatic Society (Annual). Chicago.

Apr. 8–10. Faraday Society Discussion on Radiation Chemistry. Leeds, Yorkshire, Eng.

Apr. 15. Massachusetts Society for Research in Psychiatry. Boston Psychopathic Hospital, Boston.

Apr. 15–17. Research and Development Associates, Food and Container Institute, Palmer House, Chicago.

Apr. 17–19. Ohio Academy of Science. Kent State University, Kent.

Apr. 17–20. American Heart Association (Annual). Hotel Statler, Cleveland.

Apr. 21. American League Against Epilepsy, Louisville, Ky.

Apr. 24–25. American Academy of Neurology. Brown Hotel, Louisville, Ky.

Apr. 28–30. Fisheries Council. Vancouver.

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4th District Branch
Medical Society of the
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